the Illinois Technograph

OCTOBER, 1949

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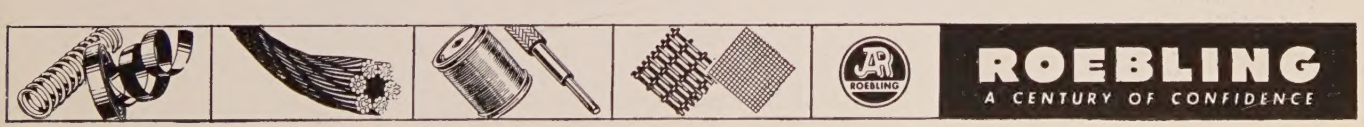

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New Developments

By Ray Hauser, Ch.E. '50

An automatic flight recorder in the nose of General Electric's B-29 flying laboratory is checked by C. L. Beattie, company engineer. (Courtesy of General Electric.)

Automatic Flight Recorder

A new type of flight recorder, which automatically records air roughness, altitude, and operation of automatic pilot and de-icing on aircraft, has been developed by the General Electric company.

Use of flight recorders will provide commercial airlines increased information on their flight operations, and make possible greater operational control.

The actual record is made by a stylus, which scratches through a thin coating on a slowly-moving strip of paper and leaves a black trace.

The flight recorder, which makes a record of flight data from take-off to landing, is so accurate in measuring altitude that it indicates changes as small as ten feet.

Rocket Power

Important research on hydrazine, the fuel of the future, is being done here by five scientists under the direction of Prof. Ludwig F. Audrieth of the chemistry department.

Hydrazine, N_2H_4, is a water-clear liquid. A derivative of ammonia, it burns completely to nitrogen and water vapor. These lightweight molecules are especially effective for pushing rockets in rarefied air or in outer space. With hydrogen peroxide supplying oxygen for combustion, hydrazine was used by the Germans as fuel for their wartime rockets.

The research promises to hasten the day of spaceships by reducing the price from four dollars to two-bits a pound.

Ductile Cast Iron

Slipping into the gap between cast iron and cast steel is ductile cast iron, a metal combining the process advantages of fluidity, castability, and machinability with such product characteristics as high elastic modulus, yield strength, and ductility.

This new metal, developed by International Nickel company, has a graphite structure in the form of spheroids; it is free from graphite in flake form. A small amount of magnesium or magnesium alloy is the effective agent when introduced into the molten iron in the cupola or in any other kind of furnace.

Its "as-cast" ductility can be increased by heat treatment.

Foul Bowls

An electronic umpire that can't dodge bottles or change decisions has been developed by General Electric for calling bowling fouls.

Actuated by electric eyes mounted on the foul line of any alley, the automatic instrument sounds a bell or buzzer and flashes a light to indicate which of 16 alleys has been "fouled."

A time delay prevents the ball from ringing the gong, but stray dogs are always caught.

Mind and Matter

According to a recent article about servomechanisms in the *Martin Star*, "physiologists have recently shown certain interrelations of nerve cells of the brain to be quite similar to links in electro-mechanical systems. Thus, thought processes or their equivalent can, in a limited way, of course, now be approached in the laboratory. It is quite possible, for example, to design a machine to play chess, to choose between winning moves and losing moves, to accumulate experiences by continuous playing, and thus to become a far better player than the man who designs it!

". . . While we can now at a cost of a few thousand dollars duplicate the function of a single brain nerve cell, the human brain has many billions of these cells, whose function would have to be duplicated, built and operated together to match its almost infinite choice of possible decisions."

What if two electro-mechanical chess players were to play a few friendly games?

Electroplate Thickness Measurement

A convenient, nondestructive magnetic method for determining the thickness of composite copper-nickel coatings electrodeposited on steel has been developed by the National Bureau of Standards.

The method involves the measurement of the attractive force between the plated specimen and two permanent

(Continued on page 38)

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The Tech Presents

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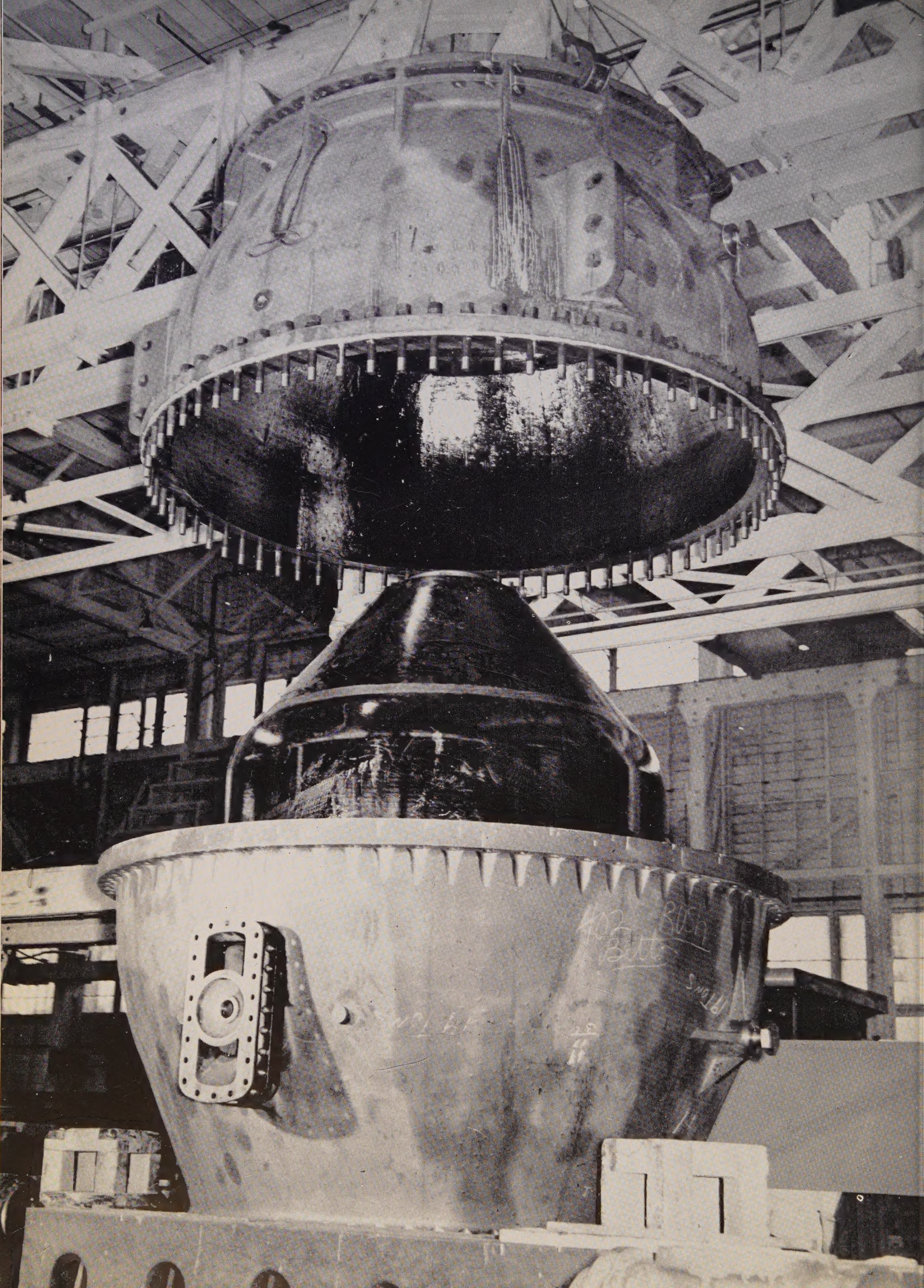
OUR COVER

Our cartoonist, Ed Lozano, gives the Alma Mater statue a North Campus twist on this month's cover. The earnest young engineer in front is guaranteed not to sit down.

FRONTISPIECE

This king-size needle valve is being assembled for installation at the Bureau of Reclamation's Friant Dam near Fresno, California. This 60-ton monster will pass almost a million gallons of water a minute. (Photo courtesy of Westinghouse.)



SLIPSTICK SHUFFLING

By Bill Soderstrum, Cer.E. '52

This article will deal primarily with the scales on the polyphase duplex slide-rule rather than the simple Mannheim rule. It will be taken for granted that most engineers already know how to perform multiplication and division on this type of rule.

For the novice, however, it can be pointed out that all numbers on the C and D scales are in direct proportion. With the C index aligned with any number, a, on the D scale, any number, b, on the C scale is in the ratio of $1 : a$ with the number, c, opposite it on the D scale. The proportion, $1 : a = b : c$, is thus represented. By algebra, this can be transformed to $ab = c$, giving us the principle involved in multiplication. Likewise, $a = c/b$ which is the principle involved in division.

CI, The Inverted C Scale

The CI scale is exactly the same as the C scale except that the CI scale reads from right to left whereas the C scale reads from left to right. With the indexes of the C and CI scales aligned, all numbers which are opposite each other are reciprocals. When performing multiplication and division with the CI and D scales, the processes are reversed. This is very useful in finding factors of any number. Set the index of the CI scale at the given number on D. Any two numbers on CI and D which fall opposite each other are factors of the given number.

Squares and Square Roots

The squares of numbers on the C and D scales lie opposite these numbers on the A and B scales. Likewise, the square roots of numbers on the A and B scales lie opposite these numbers on the C and D scales. Some confusion is encountered here, however, when trying to place the decimal point.

We shall call the left half of the A scale A_1 and the right half A_2 for simplification. A_1 may represent 1 to 10, and A_2, 10 to 100; or A_1, 100 to 1000, and A_2, 1000 to 10000, etc. Likewise, A_1 may represent 1 to .1, and A_2, .1 to .01; or A_1 may represent .01 to .001, and A_2, .001 to .0001, etc.

Squares of numbers on D may be read directly from A and the decimal point placed by inspection.

When finding the square roots of numbers greater than one, begin at the decimal point and mark off the integers in groups of two proceeding to the left. If the last group contains one figure, use A_1. If it contains two, use A_2. When finding the square roots of decimal fractions, proceed to the right of the decimal point marking off the integers in groups of two. If the first group that contains integers other than ciphers contains one figure, use A_1. If it contains two, use A_2. In either case the square root contains the same number of integers as the number of groups in the given number.

This article explains some of the less familiar uses of the slide-rule that may be valuable timesavers. It is assumed that the reader is familiar with fundamental uses, but hoped that a couple new tricks may add to the speed of operation.

Multiplication and division can be performed on A and B as well as C and D, but greater accuracy is obtained from the C and D scales. The A and B scales can be used with the C and D scales in problems involving squares and roots, such as, $a^2b = c/d^2$ *and* $\sqrt{ab} = c/d$.

Cubes and Cube Roots

The cubes of numbers on the D scale are found on the K scale, and the cube roots of numbers on K are found on D. For simplicity, we shall call the left section of K, K_1, the center section, K_2, and the right section K_3.

K_1, K_2, and K_3 may represent 1 to 10, 10 to 100, and 100 to 1000 respectively, or 1000 to 10000, 10000 to 100000, and 100000 to 1000000, etc. Likewise they may represent 1 to .1, .1 to .01, and .01 to .001 respectively, or .001 to .0001, .0001 to .00001, and .00001 to .000001, etc.

For numbers greater than one, begin at the decimal point and mark off the numbers into groups of three figures proceeding toward the left. If the last group contains one, two, or three figures, use K_1, K_2, or K_3 respectively.

If the cube of a number is found on K_1, K_2, K_3, to find the number of figures of the cube, multiply the number of figures in the given number by three and subtract two, one, none respectively.

If the cube root of a number is found from K_1, K_2, K_3, to find the number of figures of the root, add two, one, none respectively to the number of figures in the given number and divide by three.

The K scale may be used with the C scale in problems involving multiplication and division of numbers with cubes or cube roots of numbers. Combinations of operations with the K, A, B, C, and D scales can solve problems involving such exponents as 3, 4, 5, 6, etc., 5/3, 4/3, 5/6, 5/9, etc. Application of the rules for exponents will make the operations obvious.

The Folded Scales, CF, DF, CIF

One of the most convenient scales on the polyphase duplex slide-rule is the folded scale. The folded scales are exactly the same as the C, D, and CI scales, but they have been split at π, 3.1416, and the indexes placed together.

All numbers on the C and CF scales, the D and DF scales, and the CI and CIF scales are in the ratio of $1 : \pi$. This is most useful in computing the ratio of the circumference of a circle with its diameter since $C = \pi d$. This ratio may be utilized in nearly all operations involving π.

It may be noticed that, when setting problems of multiplication and division on the C and D scales, some of the numbers involved run off of the scale, and the indexes have to be exchanged. The primary purpose for the folding scales is to avoid such inconvenience.

In solving the problem $52 \times 7 \div 13$ on the C and D scales, it will be noticed that such a shift of indexes is necessary. If, however, one sets 13 on C opposite 52 on D, the answer can be read on DF opposite 7 on CF without having to shift indexes.

If the same operation is tried on the problem $52 \times 9 \div 13$, however, it will be found that even when using the CF and DF scales in this manner a shift of indexes is required. To overcome this, set 13 on CF opposite 52 on DF and read the answer on D opposite 9 on C.

Many other uses may be made of the combinations of these scales.

The Log Scale

The L scale has 10 divisions equally spaced. By this arrangement the logarithm of any number on the D scale can be found opposite it on the L scale when the indexes are aligned.

The Sine and Tangent Scales

The sine of the angles which are found on the S scale can be read on the

(Continued on page 20)

Trusses Across the Rhine

By Connie Minnich, C.E. '51

This is the third and last of a series of articles about our wartime engineering accomplishments. Connie has vividly described some of the difficult bridge-building feats that made possible the rapid occupation of Germany.

When Patton gave his Army Engineers three weeks flat to repair 32 bridges across the Rhine for his thrust into Germany—he got what he wanted. The last bolts on many of these bridges were tightened and tested as the first supply trains and trucks rolled across the river on Rhine D-Day.

Miracle? No, just a daily occurrence for the engineers in the E.T.O. Bridges such as this, built on less than scratch at the rate of one and one-half a day, were by no means the most beautiful or the most lasting of structures. However, for the war days when strength, speed, and super-efficiency were the by-words, aesthetic design and lasting wear were, for the greater part, kicked out.

After the capture of Cherbourg in the early summer of '44, U. S. Army Engineers began a large scale reconstruction program encompassing all of the important railroads and their bridges that covered the territory from Cherbourg through Normandy and down to Paris. Most of these "bridges" were structures that were built on top of or over the wrecked bridges left by the retreating German Army. Some of these were erected from materials found on location; others were constructed of American and English prefabricated units.

The most generally used construction equipment was four types of prefabricated British - manufactured beams. These consisted of the LST and HST types, light and heavy steel trestling columns that came in two weights and four lengths up to 12 feet and which were used in piers; UCRB, a kind of parallel-cord Pratt-truss span known as the Unit Construction Railroad Bridge; and RSJ's, rolled steel joist spans that were girders made by welding together two or three I-beams. These construction units were handled in sections light enough for one man to carry. They were easily and speedily assembled at the site of building.

Spanning the Albert Canal

To the north, the large Albert Canal in Belgium also became an important link in the supply lines. Repairs of its locks and broken bridges were also rated as a major engineering operation. It was, in fact, over this canal that one of the most extraordinary examples of the famed Bailey bridge was constructed. The Bailey bridge, a design of temporary structure as used by Army Engineers in the war, came in lightweight truss panels that were put together in many combinations serving as everything from piers and decks of bridges to construction trestles.

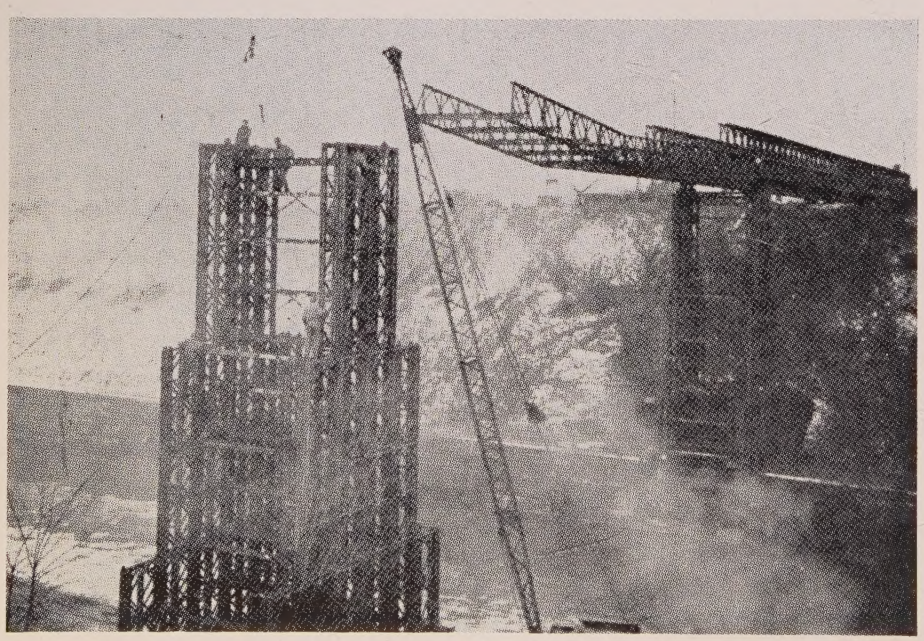
Credit for the construction of this grandpop of all Baileys goes to the 3053rd Combat Battalion of the Ninth Army who turned it out in a new record of 24 hours. The bridge, a "double-triple" design (two tiers of three parallel trusses at either side of the roadway), has three span lengths of 151, 152, and 121 feet; and both superstructure and 52-foot high piers are composed of 5x10 Bailey truss panels.

Existing conditions when the Engineers moved in to begin operations were the 122-foot canal itself, a 10-foot towpath on the east side, a 33-foot road on the west, and 60-foot banks with a 2:1 slope. Construction began with the setting of timber cribbing foundations followed by pier erections. A cableway laid the first three tiers of trusses on the east bank, while on top of the same slope, the superstructure was being assembled. To this fabrication was then attached the temporary "launching nose."

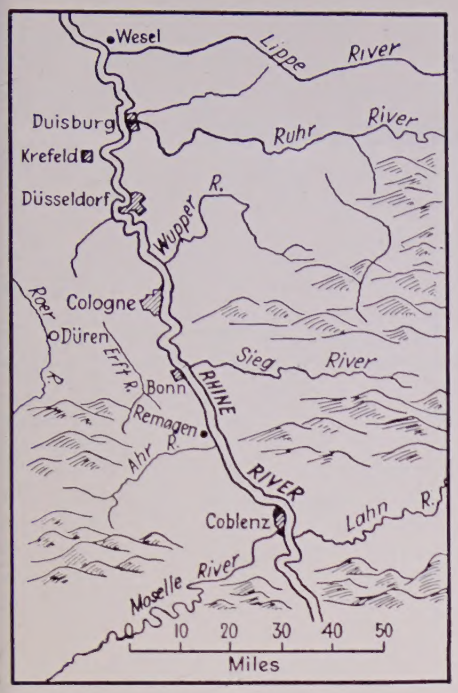
Characteristic of all Bailey bridges, this "nose," consisting of several lengths of "single-single" makeup (one tier of a single truss at either side of the road) was light enough to be pushed over the bank, cantilever style. Here it was temporarily anchored back on the bank and then, from its tip, block and tackle lowered the two top tiers of the east pier into place. Superstructure and nose were then cantilevered out over the canal to the east bank where the pier on that side had meanwhile been hoisted into place by a crawler crane. The span then continued to the top of the west bank. Operations were concluded with the lowering of the deck into its supports and jacking it into place.

Early Difficulties

In the days that preceded the Rhine invasion, supplies and materials were heaped in great dumps along the banks of the river that had been cleared of the retreating enemy. The Rhine itself



A crane tops out the 52-foot tower of Bailey truss panels at the Albert Canal just as the launching nose of the bridge arrives. (Courtesy of McGraw-Hill.)



This 10-mile stretch of the Rhine, from Coblenz to Wesel, figured in the plans for the D-day assault. (Courtesy of McGraw-Hill.)

was one huge muddle into which had fallen the ruins of every bridge between the Netherlands to the north and the French city of Coblenz to the south. The eastern bank of the river bristled with Nazi encampments; on the western bank, the First, Third, and Ninth armies had ensconced themselves in formidable strength. Both forces on either side of the river were, like the cat-and-canary parable, waiting for the other to make the first move.

The break finally came and came fast. The site was Wesel, a little town of originally 50,000 inhabitants, situated plunk in the middle of the Rhine battlegrounds. Previous to the Wesel crossing, an earlier bridgehead had been established at Remagen, where one lone railroad bridge was found still standing upon which the Engineers Corp had founded high hopes. This, however, proved a fluke when heavy German shell-fire fatally severed the top chord of the three-span tied-arch design. Vibrations set up by gales of wind caused buckling and deflections that at last finished off the structure.

Across at Wesel

Wesel was the only reasonable path across the Rhine. At the cities of Cologne, Dusseldorf, and Duisburg, the river-bed was glutted with rubbish of their world-famous bridges. South of Coblenz, the river swept through gorges and between cliffs that were ill-suited for only temporary structures. These mountainous districts were replaced further to the north by a widening river sweeping into fertile farmland and deep gravel beds. This, however, was too far down the river for the sake of convenience.

American forces opened the siege at Wesel on the night of March 22, 1945, with 3,000 bombers kicking up the dust around German fortifications on the east bank. The next night, the artillery shredded up what was left and the following morning found both engineers and troops on the captured banks.

Once over the river, the infantry fanned out and advanced several miles inland to eliminate all possibility of enemy fire while the bridge-building was in progress. Right on schedule, floating temporary bridges including a treadway, a heavy pontoon, and a floating Bailey, spanned the river 50 hours after the opening assault. In addition, crews had already begun work on the now-famous Wesel railroad bridge. The 2,215-foot bridge, completed in 10 days, was almost entirely prefabricated and consisted of LST piers set on timber pile foundations and a deck of 75-meter spans with deck sway bracing of timber spreaders and steel yokes.

This arrangement of deck sway bracing was a design detail frequently employed in these temporary bridging operations to eliminate the time-taking element of welding of the diaphragms and sway bracing to the bridge girders. Work on this bridge was sometimes carried on in as high as 15 different locations along its course.

And so, it was just 15 days after the crossing of the Rhine that the first train rolled across the river taking supplies to the advancing army spearhead.

With the subsequent invasion and capture of the Fatherland came the task of repairing the railroad and highway bridges that would make possible the lifeline supply of food for vanquished and for conquerors. Particularly interesting were the repairs of the German "autobahn" (superhighway) bridges.

Suspension bridges on the autobahns were, of course, completely ruined and only their piers could serve as the base for new river crossings. Steel bridges, it was found, were easily destroyed but were as easily repaired if no parts were missing. Truss and plate-girder bridges were simply repaired providing the damage had not resulted in excessive twisting. If sections had fallen down, they were hoisted back into place and replaced on temporary supports, which, in some cases, amounted to no more than a new set of bearings.

One of the biggest problems encountered was the masonry and plain concrete bridges that had been a favorite design with the German engineers in the absence of steel diverted into armament channels. Without steel reinforcing, many a multiple-arch bridge was ruined even though only one arch had been destroyed.

Such structures were designed so that the horizontal thrust from one of the arches was supposed to eliminate the equal but opposite horizontal force from another arch, the whole bridge then only subjecting its piers to vertical loads. With one gap in an arch, the horizontal thrusts from the other arches accumulated in the end piers of the gap, thus weakening them considerably.

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The Adolph Hitler bridge at Krefeld-Werdingen combined suspension and cantilever action to achieve stability. (Courtesy of McGraw-Hill.)

My Mother was a Phonograph

By Carl Blanyer, E.E. '51

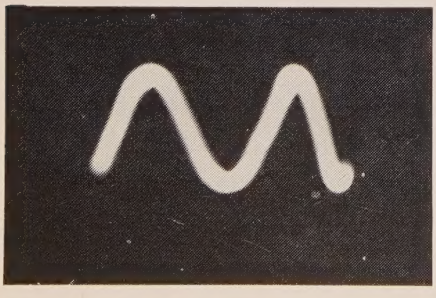
In 1937, after 56 years in the Smithsonian Institute, Alexander Graham Bell's first practical model of a recording machine was removed from its niche, dusted off, and the original cylindrical wax record played back. When this granddaddy of all record players was cranked up it spoke approximately thus:

"The following words and sounds are recorded upon the cylinder of the 'Gramophone.' . . . There are more things in heaven and earth, Horatio, than are dreamed of in our philosophy. . . . I am a gramophone and my mother was a phonograph."

Now its greatly modified offspring, the modern phonograph, is as standard a piece of equipment in the average American home as the radio, the telephone, and the family car; it is just another of the commonplace marvels of our technology that the world's music, past and present, can be brought into our homes under our personal control.

There are three basic units utilized in the recording and reproduction of sound; they are (1) a device for the transformation of mechanical vibration into varying electric voltages (the microphone in recording and the pickup in playback); (2) amplifiers usually involving vacuum tubes and associated apparatus to build up the tiny amounts of power generated by the microphone or pickup; (3) a device for the transformation of the electrical power furnished by the amplifier back to mechanical vibration (the cutter in recording and the loudspeaker in reproduction).

Except in the case of home recording enthusiasts the engraving of the sound track on records is out of the hands of the listener; but in most commercial records the quality of the recording is such that the phonograph on which the record is played is the limiting factor in the quality of the resulting sound.



This sine wave was photographed from an oscilloscope. It is actually a picture of familiar 60-cycle hum.

To understand the process one must first have some idea of the character of sound waves, particularly those produced by musical instruments and the human voice. The student of physics knows that sound consists of so-called longitudinal waves in air or other transmitting media. Sound causes alternate compression and rarefraction of the air; if the ear drum, or the diaphragm of a microphone, is in the path of a sound wave, it will vibrate in time with the frequency of the sound wave. A "pure" sound wave causes the air to compress and decompress smoothly according to a mathematical curve (a sine curve, formula: $y = A \sin \omega t$).

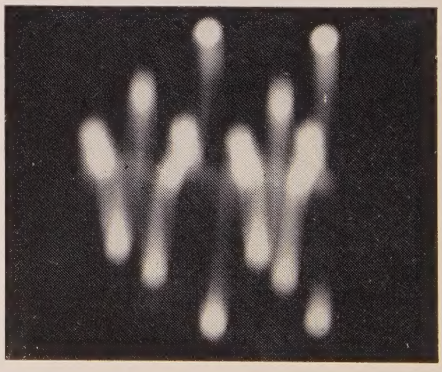
For instance, a sound wave of 440 cycles per second (A above middle C on the piano) causes the air at any given point to compress, return to normal, become rarefied, and again return to normal 440 times per second. However, most sound waves do not rise and fall smoothly, according to the sine curve; all sound waves of the same basic frequency repeat themselves at the same time interval, but the graph of intensity of air compression with time is a highly irregular curve.

Yet even the most complicated wave can be broken down into components such that each one consists of a sine wave, which is usually an integral multiple of the basic frequency of the sound wave (at least in musical tones). These individual sound sine waves, of the proper amplitude and frequency, when added vectorially, give the original sound wave. These components are called harmonics by the sound man, and overtones by the musician. They give quality or timbre to the sound, and are the reason for the difference in sound of different musical instruments and voices, even when each produces a sound of the same basic frequency.

The human ear can hear sound waves of frequencies between roughly 30 and 18,000 cycles per second; as a person ages, the ability to hear very high-pitched sounds decreases so that the upper limit of hearing may come down to 10,000 cycles or lower. Below about 30 cycles each individual pulse can be "felt" rather than heard; a machine gun firing 1,200 rounds a minute (20 per second) produces not a tone, but a series of individual pulses which can be felt more or less individually. The piano produces sound waves of frequencies ranging from 27½ cycles per second (the lowest note) to 4096 cycles (the highest). However, even the lowest note produces harmonics with frequencies of many thousands of cycles; electronic apparatus could probably detect a trace of the 100th harmonic (2750 c.p.s.).

The voice produces sound of basic frequencies from 100 to 1000 cycles per second, and is very rich in overtones, some of which extend to 8000 cycles; vowel sounds have the least harmonics (the letter *u* pronounced "oo" comes fairly close to heing a pure sine wave), while the consonants can hardly be said to have a basic frequency. They are impulses rich in harmonics. Whistling produces a practically pure high frequency sine wave of sound.

It is evident that any device intended to transmit sound faithfully must, among other things, be able to transmit equally well sound waves (or their corresponding electrical waves) of frequencies from 30 to 18,000 c.p.s. Imagine a musical tone of, perhaps, 300 cycles, with overtones up to 3000; each overtone has an intensity which is a certain definite percentage of the basic tone. If, in transmitting this composite tone, some of the harmonics were diminished, the resulting sound would be boomy and throaty compared to the original tone; if the overtones were increased in intensity, in proportion to the basic, the result would sound tinny.



The complex sound wave above is the graph of two cycles of a saxophone note—low "C" on an alto horn.

However, if the device is only intended to transmit speech, the object being understandability and not beauty of the sound carried (as in the telephone or aircraft radio) the transmission of frequencies from 200 to 2000 or 3000 cycles is enough; anything beyond contributes to naturalness but not comprehension.

In the recording of sound, a microphone picks up sound waves and changes them to corresponding voltages. These voltages are increased by amplifiers and fed to a cutting head which changes the varying currents to mechanical motion of a cutting stylus set into the head. This stylus, like a tiny chisel, carves a V-shaped groove which spirals toward the center from the outside in the surface of a plastic coated record; most commercial records (not the long-playing variety) are cut about 88 grooves per inch, radially.

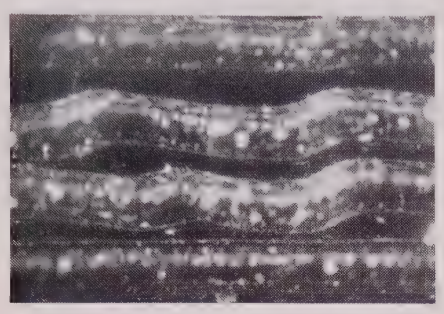
The cutter stylus vibrates in time with the sound waves picked up by the microphone, and the groove which normally is a smooth spiral becomes a wavy trace. This trace, magnified, would appear as a miniature graph of the variation of air pressure with time, or a graph of the sound wave. Commercial discs are molded from a metal "negative" made from the original "master," which is never played.

When the record is played back a needle is set into the groove; as the record spins, the needle follows the groove and is mechanically forced to vibrate from side to side. The needle may be mounted in one of several devices designed to change this mechanical vibration into electrical voltages. These voltages are proportional to the displacement of the needle in crystal cartridges, and to the side-to-side velocity in magnetic units.

The most popular cartridges use a piezo-electrical salt crystal with properties such that a mechanical twisting or bending of the crystal causes a voltage to appear between the contacts on opposite faces of the crystal. If the modulated groove causes the needle to vibrate 440 times per second, the crystal produces an alternating voltage of 440 c.p.s.; if the tone engraved in the groove has 75 assorted overtones, the crystal produces 75 harmonics; if the needle vibrates twice as far at one time as another, the crystal produces twice the voltage.

A typical crystal will produce about one volt between its opposite faces. However, the current which can be drawn from it is so small that the electrical power produced is on the order of a few millionths of a watt. This is barely enough to be audible in a pair of headphones. To build this up to a value large enough to operate a loudspeaker, vacuum tube amplifiers are used.

The action of amplifiers is too complicated to be discussed here; their operation can be compared to a valve in a water pipe. Just as a small force on the valve handle will control large amounts of water under high pressure, a small voltage on the grid of a vacuum tube will control relatively large currents in the plate circuit and cause large variations of voltage there. An alternating voltage of one volt applied to the grid of a typical triode vacuum tube might cause an alternating voltage on the plate of 60 volts—an amplification of 60 times. Certain tubes can be made to amplify as much as 350 times. Where



The periodic side-to-side deviation of record grooves caused by the cutter vibrating under modulation are illustrated in this microphotograph. The bright spots are highlights from irregularities in the bottom of the grooves.

greater amplification is necessary, several tubes are connected in "cascade" so that the output of one is fed into the input of the next, and the individual gains are multiplied. By this system carefully designed amplifiers can be built which will amplify several hundred thousand times.

Special power-handling tubes are used as the final or output tubes in amplifiers; their gain is low (about 10 times), but fairly large currents can be drawn from them so that they are capable of delivering several watts of power. At normal room volume a phonograph amplifier is driving the speaker with little less than one watt. Two or four tubes can be used in special circuits ("push-pull" or parallel or both) for the final amplification stage to produce much larger amounts of power; some large public-address amplifiers are capable of delivering 50 to 100 watts to the speakers.

Vacuum tubes are "high impedance" devices—they control rather high voltages at low currents. On the other hand, a speaker is a "low impedance" mechanism, requiring only small voltages but drawing large currents. Therefore a transformer is used to transfer the electrical power from the final tube or tubes to the speaker and at the same time "match" the two highly different units. Transformers change voltage and current in opposite ratios; if the ratio of the turns of wire is such that the voltage in the secondary is halved, the current is doubled, and vice versa. No increase in power can be made in a transformer, but very little is lost; they are on the order of 98 per cent efficient, one of the most efficient machines ever invented.

The speaker is a device for changing alternating currents to mechanical vibrations in air—that is, to sound waves. When the alternating current originally produced by the crystal in the tone arm has been suitably amplified, it is fed to the speaker's voice coil, which is suspended in a strong magnetic field. As the current changes cyclicly in the voice coil in time with the vibrations of the needle in the record groove, the coil is forced back and forth in the magnetic field. Since it is rigidly attached to the center of the cone of the speaker, the cone also vibrates, compressing and decompressing the air, and causing sound waves which are more or less accurate replicas of the original sound recorded on the record.

As one might expect, there are many chances for imperfect operation in the chain. Each separate unit which carries the sound, whether as actual sound waves or the corresponding alternating voltages, must act linearly; the output of it must be in accurate proportion to the input no matter at what frequency or set of frequencies it is operating. With all the possibilities for distortion it seems rather remarkable that the sound from an amplifier's speaker is so much like that of the original. Consider the fact that the paper cone of a $5.00 speaker driven by possibly four little tubes must attempt to set up sound waves corresponding to those produced by perhaps $10,000 worth of instruments of a 75-piece symphony orchestra.

Amplifiers themselves can be designed with very small distortion; they can be, but often aren't. Most of the "amplitude distortion," or departure from strict proportionality, of amplifiers occurs in the final or output tube; and in many small amplifiers such as are used in radios and phonographs the distortion runs as high as 12 or 15 per cent. In the better quality amplifiers it is around 5 or as low as 2 per cent.

Also important, as mentioned before, is the ability to amplify equally all frequencies over a wide range. Since the tubes used in ordinary amplifiers will work quite well at frequencies as high as 20 million cycles per second (and as low as zero, or direct current), and since circuits almost like the ones in phonographs can be made to work from below 20 c.p.s. up to 2 or 3 million c.p.s., it is obvious that little trouble should be experienced in making them operate to only 18,000 cycles.

(Continued on page 26)

Opportunities in Metallurgical Engineering

By Robert Bohl, Metallurgical Engineering Department

Metallurgy is one of the important, but overlooked fields of engineering. The following is an explanation of the need, work, and training of metallurgical engineers, and the facilities available right here in our own back yard.

In recent years, graduates of the engineering colleges have enjoyed the advantage of a great demand for their services. In all branches of engineering, the graduate has been able to choose almost at will the type of work, locality, and employer which he desires.

But the shortage of engineers which has fostered this situation is becoming satisfied in many fields. Recent surveys indicate an actual or impending surplus of engineers in many fields. As a result, graduate engineers must again consider the possibility of having a difficult time to find satisfactory employment. This is especially true in the fields of engineering which have been popularized during the war, and in which men were trained by the services.

The men who are freshmen and sophomores in engineering schools now need to consider the advice of men such as Karl Compton, president of Massachusetts Institute of Technology, who has advised college men to enter the fields of mining, metallurgy and ceramics, to ensure that adequate opportunities will be available for employment after graduation.

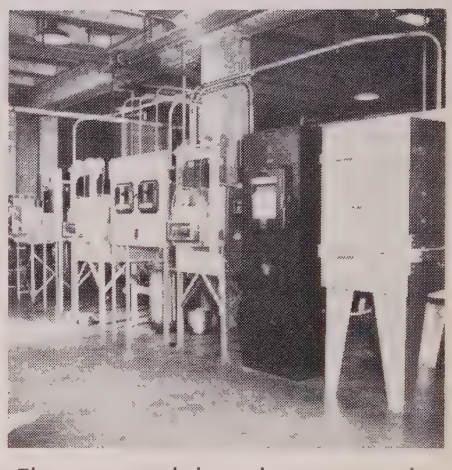
In this article, some attempt will be made to explain the field of metallurgical engineering to those first and second year engineering students who have not already decided their particular field of specialization. It has become apparent that many young men on the campus have little or no idea of what metallurgical engineers do, that a complete curriculum in metallurgical engineering is offered at the University of Illinois, or that this department enjoys the reputation of being one of the finest in the nation. Employers from all over the country have declared their satisfaction with the training of men graduated from the University of Illinois.

The facilities of the department at the University include the Metallurgy laboratory, and offices and classrooms in the Ceramics building. The Metallurgy laboratory is a two-story building located between the Transportation and Ceramics buildings, and houses a machine shop, offices and classroom, and laboratories for welding, electrometallurgy, heat treatment, casting, metallography, and research.

Opportunity Plus

The enrollment in metallurgical engineering all over the country is very low in comparison to the demand for metallurgists. This is apparently due to a lack of understanding of the field by many students. Hence, in spite of the great increase in demand for metallurgists, the enrollment of this department is now about equal to the prewar enrollment, while some other departments have doubled and tripled their prewar enrollments.

As a consequence of this fact, many more job opportunities exist than there are graduates to fill them. As an example, the graduates of the department continue to enjoy a large selection of employment offers. Industry assures us that there is no foreseeable end to this under-saturation in the light of present enrollments. Figures released by industry show that the starting salary received by metallurgists is greater than that of any other field except chemical engineering, with the same trend continuing with increased experience.



These control boards operate the furnaces in the heat treatment laboratory.

Metallurgy as an art has existed for centuries, but the science of metallurgy has developed within the last generation. So it is natural that in such a new field, few people are familiar with the type of work in which the metallurgist is engaged. In order to permit a better understanding of the field, let us briefly describe metallurgical engineering.

The field of metallurgical engineering can be conveniently divided into two categories, process metallurgy and physical metallurgy; although some prefer to further classify the latter as mechanical metallurgy and physical metallurgy.

(Continued on page 24)

Students examine specimens in the metallography laboratory of the University of Illinois' well equipped Metallurgy Department.

In This Corner... NAVY PIER

ENGINEERING SOCIETIES

By Ed. Pahl, E.E. '53

The Student Engineering Societies Council was organized about one and one-half semesters ago, with the purpose of integrating the engineering societies' activities. Its first semester of active existence was successfully realized with the presentation of the St. Pat's Ball and with the engineers' Spring Picnic (it rained, but a good time was had by all).

Member societies represented in the Engineering Council are chemical engineers, electrical engineers, civil engineers, mechanical engineers, aeronautical engineers, and the Penaleare society. Each of these engineering societies sends its vice president and an elected representative to the Council meetings. At these meetings the activities of the various societies are discussed, and an effort is made in every case to secure cooperation of all the engineers in the execution of these activities.

The Engineering Council occasionally sponsors activities, such as the St. Pat's Ball, which are enthusiastically supported by students in all of the school's colleges. If this coming semester is as successful for the Council as was last semester, there is no doubt that this outstanding organization will continue to serve the students of Navy Pier.

A.I.E.E.

The A.I.E.E. is cordially inviting all electrical engineering students to its first meeting of the semester on October 5, 1949, at 3:00 p. m. There will be a movie on the *Life of Thomas Edison,* followed by a short meeting to start planning the semester's activities.

The activities will include inspection tours of different electrical plants throughout Chicago, and inspiring lectures on the professional and technical sides of electrical engineering.

The A.I.E.E. was organized for the purpose of the advancement and dissemination of the knowledge of the theory and practice of electrical engineering, the presentation of a proper perspective of engineering work, and the opportunity to become acquainted with the personnel and activities of the American Institute of Electrical Engineers.

A.S.C.E.

The A.S.C.E. will elect its new officers in the fall. The outgoing president, Mr. Frank Koepke, will call the first meeting in October, when officers will be elected for 1949-50.

The society urges you to join as soon as possible so that you may take advantage of its activities. It offers a scholarship to one of its members for which all members are eligible.

The society is planning to have its meetings once a month as in the past. A number of prominent engineers have promised to be speakers, and it should have several good and interesting meetings.

The American Society of Civil Engineers, Illinois section, is also going to entertain the students at a meeting similar to the one held last year. The meeting will be held at I.I.T. in November.

Here's bidding all new men welcome.

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Mr. Ogden Livermore, *Faculty Adviser*

PIER PERSONALITIES

By Oleg Terichow, Met.E. '51

One of the better known educators, whom every engineer at the Pier eventually meets, is J. S. Kozacka, associate professor of mechanical engineering and head of the department of shop laboratories.

Professor Kozacka is not only well known at the University, but is a leader in various engineering organizations and civic groups in the Chicago area as well. His combined rich store of practical experience and theoretical knowledge serves as an invauable tool in his teaching to the students in the engineering curricula.

Professor Kozacka was born and received his early education in Tarnow, Poland. He arrived in the United States in 1904, and has lived here ever since. He became a naturalized citizen in 1913.

After serving apprenticeship as a machinist-toolmaker, he entered Pratt Institute in Brooklyn, N. Y., in 1909. Upon graduation he was advised to study engineering at the University of Michigan.

His first outstanding job after his completion of studies at Pratt Institute, was that of tool and die maker, and later as a foreman at the United States Motor company, now the Chrysler corporation.

He entered the University of Michigan in 1912, graduating with a B.S. degree in mechanical engineering in 1916. While at Michigan, he participated in the intramural sports, wrestling and boxing. Also, he served as an assistant to a professor in shop management courses during his senior year.

After he graduated, he worked with the Packard corporation in production and control of materials. He went back to the University of Michigan after a few years and received his M.S. degree

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J. S. Kozacka. (Photo by Robert Groemling.)

The Engineering Honoraries and Societies

By Dan Keefe, Ch.E. '50

ENGINEERING COUNCIL

The Engineering Council, consisting of two representatives from each of the engineering societies plus two delegates from the *Technograph,* has a big job ahead of it this year. Its main task is to coordinate the efforts of the various engineering groups in all their mutual activities.

The program is full of big deals. The largest engineering social event of the year will be St. Pat's Ball, which will be near the "Great Day for the Engineers." Participation in the all-University Career Conference has been planned.

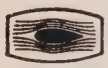
During that week, the combined councils of the various colleges will bring to the campus a large group of well known speakers, representing every major field of activity, to speak to the students in order to aid those who are undecided about their life work. Each speaker will make a talk before a group, and then private conferences with individual students will be scheduled so that each may gain personal consultation.

A new item on the roster is an all-Engineering Open House similar to those held a few years ago—but bigger and better.

You'll be getting all the details of these activities through your society representative, and you'll find the latest scoop right here in the *Tech.*

The officers of the Council are Richard Wurzburger, president; Ray Hauser, vice president; William Campbell, secretary; and Harold Wilson, treasurer.

I.A.S.



At the last meeting of the spring semester, the following officers were elected by the Institute of Aeronautical Engineering: Allen M. Benson, president; Edward J. Cenek, vice president; and Byron L. Gubbert, secretary-treasurer.

There isn't too much news from the I.A.S. at this time but if you'll check Cloud 39 over the Engineering campus you're certain to find any of the members eager to give out all the latest prop wash.

A.F.S.

At their last meeting in the spring, the American Foundry Society made plans for this fall semester. The first event on the schedule was a fish fry that was held in conjunction with the October meeting. Plans are also in the making for the annual banquet which will be held next spring.

The incumbent officers were Paul Green, president; Harold A. Rodbro, vice president; Keith Van Ness, secretary; Art Van Sant, treasurer; and James Garman, Engineering Council representative. (New officers were elected at the first meeting on September 27.) You may get all the information that you want from Mr. James Leach, faculty adviser.

S.B.A.C.S.

This impressive list of letters stands for the Student Branch of the American Ceramic Society. The society is just as impressive as its name.

Established a few years ago to help the students and faculty keep in closer contact, the society has become very active. They have frequent talks about their profession, and the demonstrations accompanying these are really something to see.

The plans for the coming year haven't been released at this time, but you may be certain that there'll be plenty doing.

Lucas E. Pfeiffenberger was elected president of the S.B.A.C.S. last spring. The other officers for this term are: Stephen D. Stoddard, vice president; Charles K. Russell, secretary; Ervin W. Schuetze, treasurer; Richard M. Fulrath, historian; and Clifton G. Bergeron and Howard Rapp, representatives to the Engineering Council.

A.I.Ch.E.

Boasting a new building this fall are the chemical engineers. The new Chemistry and Chemical Engineering building, officially named East Chemistry, is at the corner of Mathews and California and is reputed to be unique in every sense of the word. One of the main events of this year for A.I.Ch.E. will be the dedication of this latest addition to the campus.

Before winding up last year's business with their annual banquet and picnic (a beer bust for men only), the Chem. E.'s made plans to participate in the all-Engineering Open House to be held later this year. Also on the agenda are some movies put out by some of the large chemical firms plus a talk by Dr. Bailar on job opportunities. The fall semester was started with a smoker last month at which time Dr. Johnstone introduced the staff and welcomed the boys back.

At a meeting held last spring, Henry Kahn was elected the chief unit operator. Giving Hank a hand with the work are: John Shurtleff, vice president; Claude Lucchesi, secretary; Donald Engelbrecht, treasurer; Robert Friedman and Dan Keefe, Engineering Council representatives. The faculty advisor for the A.I.Ch.E. is Dr. James W. Westwater.

A.I.E.E.-I.R.E.

The dedication of the new E.E. building last spring has left its mark on the electrical and radio engineers. The rumor making the rounds, not confirmed or denied, is that the new building was put up to show their arch-rivals that the E.E.'s could do it better.

Along that line, the E.E.'s plan to continue the "friendly" get-togethers with that *other* society; these meetings will probably take the form of mutual interest lectures and maybe another quiz show. Also on the agenda for the coming year is participation in each and every activity that the other engineering groups want to have. It was proposed that the list include football, basketball, bowling, and a few other manly contests with no holds barred.

The seniors are trying to have the annual field trip re-established after a lapse in this activity during the war.

All the latest news can be obtained through the WATT METER or the following officers: Charles Eletson, chairman; Chuck Green, vice chairman; Dick Storer, secretary; Tom Daggett, treasurer; Dick Gorozdos, I.R.E. corresponding secretary; Joan Hessler, A.I.E.E. corresponding secretary, and Vincent McDonald, Engineering Council representative.

I.E.S.

A new organization on campus, established in 1948, the Illuminating Engineers are starting to throw a big light out around the north end of the campus. The society has the honor of

(Continued on page 32)

Introducing . . .

By Dave Cash, Ag.E. '51
and Dan Keefe, Ch.E. '50

PROFESSOR EDWIN D. LUKE

All over the engineering campus last spring the student engineers took a poll to determine the most effective instructor in the various departments. The award in the Department of Mechanical Engineering went to Prof. Edwin D. Luke.

Professor Luke was born in 1915 in Gilmer, down in the Lone Star State of Texas. He attended elementary school there and spent his high school days in Pyote, Texas, where he graduated in 1932.

In 1933, he entered John Tarleton Agricultural College where he stayed for the next two years. Then, in 1935, he transferred to Texas A&M. He received his bachelor of science there in 1937 in the curriculum of mechanical engineering. He stayed on at Texas A&M until 1938 when he received his master's degree.

EDWIN D. LUKE

In September, 1938, he came to the University of Illinois and is now an associate professor of mechanical engineering.

Professor Luke entered the Army Ordnance department as a 1st lieutenant in June, 1941. He spent three years in the Hawaiian Islands, and after being discharged he returned to inactive duty in February, 1946, as a lieutenant colonel of the Ordnance department.

One of his main interests now is his job as a member of the Board of Appointment of Student Membership to the American Ordnance Association. Each year a certain number of students are admitted and Professor Luke, with Dean Jordan, aids in the selection.

Professor Luke is married and has one child, a son. He makes his home in the northwestern part of Champaign.

O. M. SIDEBOTTOM

When he entered high school, Mr. Sidebottom had no thought of going to college. During his senior year a representative of Lincoln Junior College, Lincoln, Ill., interested him in going to school there. Although born and raised on a farm near Easton, Ill., he found he liked mathematics more than shucking corn. He didn't think he would be interested in teaching and so decided to take engineering.

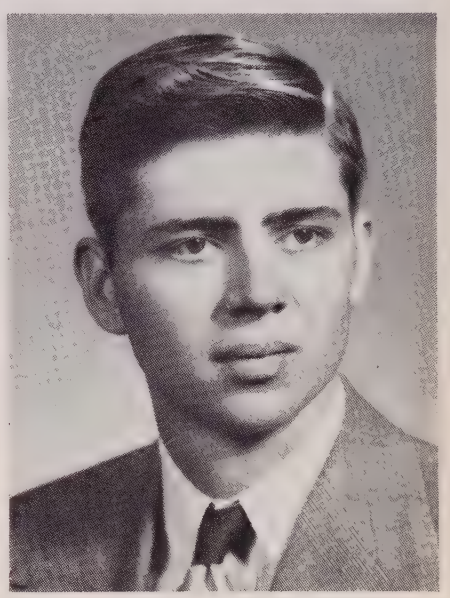
At Lincoln he was aware of only two fields of engineering, electrical and mechanical. After trying to read a book on electricity he decided upon mechanical engineering and came to the University of Illinois in 1940. He graduated with a bachelor of science in mechanical engineering in 1942 and was asked if he would like to teach. He thought that it would be good experience. As he had liked the theoretical and applied mechanics courses better than the mechanical engineering courses, he decided he would rather teach T.A.M.

O. M. SIDEBOTTOM

He received his master of science in 1943 and worked on research under Professor Schrader for four years. In 1947, he and Dimitry Morkovin published a bulletin, *The Effect of Non-Uniform Distribution of Stress on the Yield Strength of Steel.* He has instructed both full-time and part-time since then and is now, with Prof. H. J. Schrader and H. R. Wetenkamp, writing a bulletin on car wheel investigation.

His hobby is fishing; he also likes to play bridge and has an interest in photography. He bought his first new car, an Oldsmobile, last June. He is unmarried.

Mr. Sidebottom is a member of A.S.M.E., Tau Beta Pi, Sigma Xi (a research fraternity), and Pi Mu Epsilon (a math honorary). He was voted a most effective instructor last spring.



RICHARD H. KANAK

From a politician in engineering to an engineer in politics is the bumpy road being traveled by Dick Kanak.

Partly explaining Dick's interest in traffic engineering is his long association with the problems concerning this field. For a year he drove daily the 20-mile trek to Navy Pier from his home in Berwyn, and he now spends week ends driving trucks around the Chicago area. Thus he has emphatically experienced all kinds of traffic conditions.

Dick has found that Professor Wiley's classes and the I.T.E. are quite valuable in finding methods of correction. He has participated in four local traffic surveys (keeping out of the way of speeding cars, bicycles, and pedestrians). His participation in the I.T.E. has been

(Continued on page 28)

By Dean Felton, C.E. '51

This is a new feature of the Tech that we hope you'll like. Its purpose is to bring to the fore some of the color and characteristics of our engineering campus. If you know of a boner pulled in lab, an appropriate crack made in class, or have a question about some of the north-campus "machinery," let us know about it.

A Model Model

Just inside the swinging doors of Civil Engineering hall is a glass-encased bridge with an interesting history.

This display is a model of a multiple span, reinforced concrete, arch bridge that was built in Talbot lab many years ago. The model, built by Prof. W. W. Wilson and his research assistants, was originally meant to be a simple example of the fundamental research carried on here. However, detail was added to make it a complete display. Before moving into C.E.H., it was shown at the Century of Progress World's Fair in Chicago in 1933.

The prototype was a reinforced concrete structure consisting of three 27-foot spans set upon piers 20 feet high. The piers were built on mechanisms designed to measure the reactions of the abutments under varied conditions of load. The load, consisting of a concrete block of known weight, was applied to points on the deck, and changes in reactions and stresses were accurately determined.

In working on these tests, Prof. Wilson aided the promotion of this multiple span type of structure, and was awarded the Crowe's medal by the A.S.C.E. for written reports of his findings.

* * *

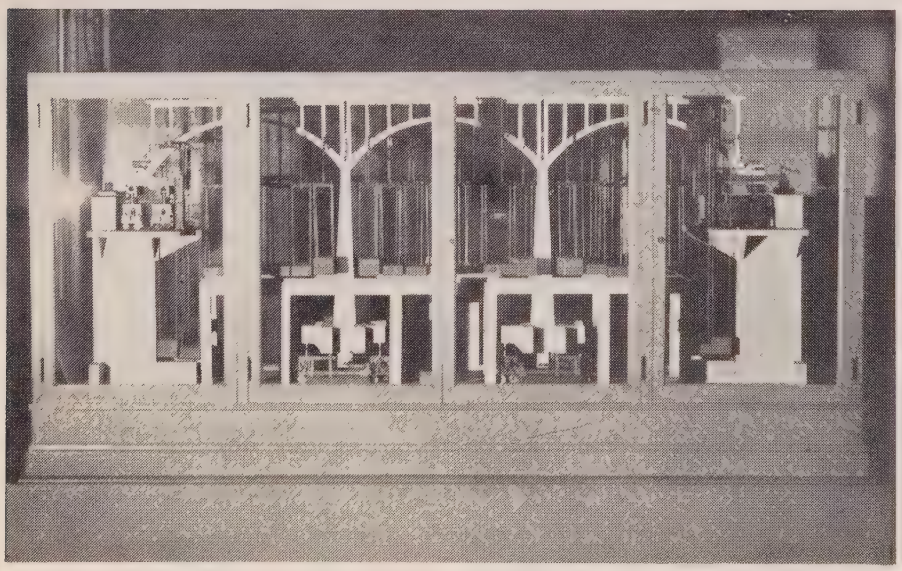
It Happened in Thermo

Dr. Comings, high pressure man in the Ch.E. department, told the following to his victims in thermo last spring.

One day while making the rounds of his ark, Noah was taking census of the animals aboard. After finding 17 rabbits, five squirrels, three giraffes, etc., he came upon two lonely snakes—the same ones he had brought aboard.

"Why haven't you multiplied like the other animals on the ship?" Noah asked.

"We're adders," was the simple reply.



The Model bridge is a familiar obstacle to anyone entering the front doors of Civil Engineering Hall. (Photo by Lou Davidson.)

As the original Barnum continued his rounds he noticed the shortage of furniture for his horde. After summoning his old friend, P. Bunyan, Noah built some crude-looking log chairs and tables.

Three days after installing them aboard the ark, Noah was suddenly confronted with a family of five snakes. "But I thought you couldn't multiply!" he blurted.

Happily papa snake replied, "We used your new log tables."

* * *

FLUSH THE BONEYARD

* * *

CONGRATS to Frank E. Richart, research professor of engineering materials on his election to the vice presidency of A.S.T.M.

* * *

New head of the E.E. department, Dr. John D. Ryder, comes from Iowa State college with an impressive list of accomplishments, and a welcoming smile. The November *Tech* will have a few words about both.

* * *

Although the new structure at Mathews and California says "Chemistry and Chemical Engineering" above its entrance, it was named "East Chemistry."

As two-fifths of the building is occupied by the bio-chem division, and three-fifths by the chem engineers, there has been plenty of grumbling by the Ch.E.'s about the apparent lack of consideration.

* * *

Who'da Thotit?

One fine afternoon last spring, a local resident was shopping in a campus drugstore with his attention-getting two-year-old son. After selecting his items, the man discovered that he had left his wallet at home.

After he explained his predicament to the cashier, a stranger nearby offered to pay the buck. Surprised at the gesture, the local resident asked where to repay the loan.

(Continued on page 22)

Optional Illusion

— but industries save if they see valves this way

THERE ARE TWO WAYS of regarding the valves in any plant. Management can think of the relatively small cost of a single valve, and dismiss it as a minor, "petty cash" investment. Or, they can think of *all* valves in the plant as *one* valve, as pictured, by photo-magic, in this pharmaceutical plant,—and see valves in proper perspective.

THEY FIND IT PAYS to take the latter view, for in *any* plant, *any* building where fluid control is involved, valves, collectively, are as important, in terms of investment and operating expense, as larger plant units, and should be selected with the same sharp eye to quality and economy.

EXCESSIVE MAINTENANCE of one inferior valve is insignificant, but multiplied by thousands, it is a serious drain on operating budgets. JENKINS BROS. helps to meet this problem two ways. First, by building extra endurance into Jenkins Valves, making them the longest-lasting, lowest-upkeep valves that money can buy. Second, with advice from Jenkins Engineers on any question of proper selection, installation, or maintenance.

That's why, for all new installations, for all replacements, so many plants rely on Jenkins quality and engineering for lowest valve costs in the long run. *Sold through leading Industrial Distributors.*

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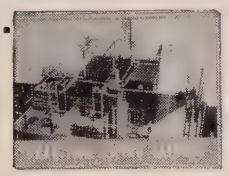

"PRACTICAL PIPING LAYOUTS" is a 32-page book containing diagrams and descriptions of 25 basic piping layouts with complete recommendations for valve selection and location in the lines. Tells you "which valve where for best performance". FREE on request. Write JENKINS BROS., 80 White Street, New York 13, N. Y.

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RAY L. HAUSER
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CONNIE MINNICH
Associate Editor

the Illinois Technograph

From the Tables . . .

When taking a new job moving to a new town, entering a new school, or even returning to school, one is presented with the problem of adaptation to an unfamiliar environment. The method of adaptation and the choice of close environment are of extreme personal importance, but are often neglected in the confusion of transition.

Especially in the change from high school to college is this self-adjustment necessary. Graduation ceremonies give one the feeling of elated achievement and a new sense of independence from the past. "I'm on my own; I'm a MAN now!" seems to be the usual sensation. The training and influence of the home and church, being things of the past, are too easily left up in the attic with the the model airplanes and high school books. The thrills of life at college await!

Except for possible financial assistance, we do achieve a partial independence of home influences. We're free to think and plan how, and if, we want to. Nobody is going to tell us to worry about right and wrong! We can choose our friends or "beer buddies" and blindly follow the lights and thrills of college if we want to!

But what is to fill the sudden vacuum of love, guidance and inspiration that were, oftimes unconsciously, received at home? Are we to blindly grope down the maze of dead-end alleys of indecision, or is there something that can lead us to a purpose?

Choices during the first few months of a college career lead to habits, which, if not deliberately broken, may cause a whole life to deteriorate.

Do we assume the responsibility of deliberate decisions regarding our purposes and goals to be attained here? Do we really know why we're here? To get a degree? To learn a living? To gain an "education"? To learn to LIVE?

A multitude of experiences may be found on the campus, and we should be "choosey" about how to make use of them. True, it's easier to thoughtlessly follow the crowds to the sensuous thrills than to be a little individualistic and strive for personal development. But the difference ten years hence is worth the effort now. We should decide NOW what kind of a life we want to live; and NOW is the time to start living it!

With our technical training concentrated on the material world, it's so easy to forget that the only real worth is the eternal world. Religion isn't kid stuff! It isn't to be left in the "Jesus Loves Me" Sunday school class. Religion can be dynamic; it should grow; it is to be lived and shared!

Here on the campus so many of us tend to slight our personal religious development even though the possibilities of gaining a genuine understanding of Man's relation to God and to Man are the best we'll probably ever know. Almost every church is represented on the campus by able and understanding leaders who are here to serve our needs for religious development.

Not only are the staff members of the church foundations and the Y top-notch, but also the students who are actively participating. They're a grand bunch of kids with the same problems as everyone else on the campus, but they're finding answers in a living fellowship. Their program of religion in action is providing a stabilizing influence that keeps one on an even keel, and clear in purpose and direction of life.

There's no such thing as "college life." There is *your* life, and there is *my* life; and we each have to live our own. And NOW is the time to decide how to live it!—R.L.H.

RCA scientists develop new *direct-reading* Loran instrument which simplifies problems of navigation.

The **homing pigeon** *goes to sea*

Now science gives the navigator an improved "homing pigeon instinct," a way by which—without checking sun or stars—he can head his ship directly home.

Already thoroughly proved, *Loran equipment* has been simplified through RCA research and engineering, so that almost anyone can learn to use it in a few minutes. Free of human error, readings appear *directly* on the instrument. A quick check gives position.

Brain of this Loran system is a circuit developed at RCA Laboratories which splits seconds into millions of parts—and accurately measures the difference in the time it takes a pair of radio signals to travel from shore to ship.

Given this information, the navigator, hundreds of miles from shore, can determine his position quickly and accurately. Loran's simplicity adapts it to every type of vessel from merchant ship to yacht. Manufactured by Radiomarine Corporation of America, a service of RCA, it is already being installed in U. S. Coast Guard rescue ships.

The meaning of RCA research

RCA's contribution to the development of this new direct-reading Loran is another example of the continued leadership in science and engineering which adds *value beyond price to* any product or service of RCA.

* * *

The newest advances in television, radio, and electronics can be seen in action at RCA Exhibition Hall, 36 West 49 St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, N. Y. 20.

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Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

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- Design of component parts such as coils, loudspeakers, capacitors.
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- Design of receiving, power, cathode ray, gas and photo tubes.

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I AM AN ENGINEER. In my profession I take deep pride, but without vainglory; to it I owe solemn obligations that I am eager to fulfill.

As an Engineer, I will participate in none but honest enterprises. To him that has engaged my services, as employer or client, I will give the utmost of performance and fidelity.

When needed, my skill and knowledge shall be given without reservation for the public good. From special capacity springs the obligation to use it well in the service of humanity; and I accept the challenge that this implies.

Jealous of the high repute of my calling, I will strive to protect the interests and the good name of any engineer that I may know to be deserving; but I will not shrink, should duty dictate, from disclosing the truth regarding anyone that, by unscrupulous act, has shown himself unworthy of the profession.

Since the Age of Stone, human progress has been conditioned by the genius of my professional forbears. By them have been rendered usable to mankind Nature's vast resources of material and energy. By them have been vitalized and turned to practical account the principles of science and the revelations of technology. Except for this heritage of accomulated experience, my efforts would be feeble. I dedicate myself to the dissemination of engineering knowledge, and, especially to the instruction of younger members of my profession in all its arts and traditions.

To my fellows I pledge, in the same full measure I ask of them, integrity and fair dealing, tolerance and respect, and devotion to the standards and dignity of our profession; with the consciousness, always, that our special expertness carries with it the obligation to serve humanity with complete sincerity.

Published by Engineering News-Record to foster the program of the Engineers Council for Professional Development.

NAVY PIER . . .

(Continued from page 13)

in education. At Michigan, he had decided that he could best serve the interests of young people by becoming an educator. "I believe that education, whether it be in a specialized field such as engineering or in studying the liberal arts, should be available to all people, of all races," he said on numerous occasions.

Upon receiving his M.S., he was appointed an associate professor of mechanical engineering and director of shop laboratories at Lewis Institute here in Chicago. With the merging of Lewis Institute with Armour Institute of Technology, he remained in the same capacity at that school, until 1943. During the war, he was in charge of the war training courses at I.I.T. in the Chicago area.

Toward the end of the war, he reentered private industry as a development and tool engineer at Vascoloy-Ramet corporation at Waukegan, Ill. There he helped in the development of carbide cutting tools. He then came here to head the shop laboratories when the Pier branch of the U. of I. opened in 1946.

Professor Kozacka's achievements in various organizations are too numerous to mention in full detail here. In 1934, he was chairman of the local section of the A.S.M.E. He was instrumental in the formation of the junior section of the local Chicago A.S.M.E., and received two honorable recognitions from that society for his outstanding contribution in that field.

He is an elected member of the Polish Institute of Arts and Sciences, and also a member of the American Society for Engineering Education. He is now working on research in the action of cutting tools, and had previously exchanged papers and data with a professor at the Warsaw Polytechnic Institute prior to the outbreak of the war. During the war he wrote a series of articles for the *Science and Mechanic* magazine on precision tools and measurements. He is co-author of a new book, *Tungsten and Carbide Cutting Tools,* which will be published soon by the Chicago Technical Society.

In addition to those organizations, he is well known in Polish-American civic groups. He was married in 1916, to the former Wanda Klopocinski, and has two sons, Richard and Arthur. Dick has already received his degree from the University of Michigan in chemical engineering, and is now the technical director of a production plant at the Monsanto Chemical company, at Monsanto, Ill. The younger son, Arthur, is currently studying mechanical engineering at the U. of I.

SLIPSTICKS . . .

(Continued from page 7)

A scale when the indexes are aligned. These angles include those from 34′ to 90°. For the sine of any angle measured in minutes, set the minutes gage point (marked ′) to the number of minutes on the A scale and read the sine on the A scale at the S index. For the sine of any angle measured in seconds, set the second gage point (marked ″) to the number of seconds on the A scale and read the sine on the A scale at the S index.

The tangent for angles between 5°43′ and 45° can be found on the D scale opposite the angle on the T scale. The tangent of angles less than 5°43′ is equal to the sine and can be found on the S scale as described above. The tangent of any angle A which is between 45° and 90° equals the reciprocal of $(90° - A)$.

This completes the scales found on the normal polyphase duplex slide-rule. Many other scales are in use, but the discussion of them is too lengthy to be dealt with here.

New Fields of Research and Achievement

. . . FROM THE AIR

* * *

Rare Gases Now Available in Quantity Offer Challenging Subject for Study

Among the least known of the elements have been the rare gases—Krypton and Xenon. Occurring in the atmosphere in concentration of one part per million for Krypton, and one part per twelve million for Xenon, their very scarcity gave them the status of "scientific curiosities" for a long time.

But now, these gases are available in quantity in refined, compressed form. As these gases assume the different role of "new" materials, their individual physical and electrical properties are finding interesting uses.

The increased efficiency of hot cathode (fluorescent) lights is a direct result of using Krypton as the gas filler. The brightest light ever made by man is produced by an electrical discharge through a column of Krypton . . . these lights are used to penetrate fog at airports.

Xenon is replacing mercury vapor in industrial (thyratron) tubes, to avoid low temperature condensation troubles. It is Xenon that makes practical the "repeater" (gas discharge) photographic flash lamp—the low resistance and good spectral range of the gas both being important. In the fast-growing field of atomic energy, the rare gases become increasingly important. The use of such gases in Geiger Mueller counter tubes is well familiar.

Chemists and physicists on many types of projects will want to study the possible value of these gases in their fields. Others may desire to work with the rare gases as such, contributing to further information in this expanding subject. Graduate students especially may find rare gases a fascinating, challenging, and wide open field for doctoral thesis.

In whatever connection, scientists who may want more information on Krypton, Xenon, Argon, etc., are invited to write us fully. Please write Dept. LAP, Room 1502, 30 East 42nd St., New York 17, N. Y.

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TRUSSES . . .

(Continued from page 9)

Such was the case with the Kaempfelbach bridge on the superhighway between Frankfurt and Munich. Originally a plain-concrete arch bridge spanning a 1,200-foot valley, the structure was almost totally destroyed, except for three piers left intact—one at the eastern end of the bridge and two others at the western end. There also remained three pier stubs in the middle of the valley which became the bases for piers for the new highway bridge that the Army Engineers constructed. To prevent failure of the existing piers at the ends due to the accumulated horizontal thrust as mentioned above, the pier to the east was braced with structural steel piping and the two piers to the west were tied back and anchored with six steel cables of 165-ton strength each.

A great deal of the steel truss bridge that was constructed as a semipermanent solution to this bridging problem was prefabricated from SKR trusses, standardized German railway bridge trusses that were simply attached by bolting. The three pier stubs in the middle of the 672-foot span that had to be crossed were leveled off, capped, and became the bases for the rocker bents that carried the superstructure. The truss superstructure itself was assembled on the western bank of the valley and then was cantilevered out to the first rocker support in the manner of Bailey bridge construction.

Perhaps the only components of the bridge that were specially manufactured for it were the top and bottom parts of the rocker bent bearings that were designed and made in a nearby steel mill. All other materials and machines used were bits of construction equipment confiscated from nearby German army supply dumps as in the case of the SKR trusses, themselves.

Unseen Difficulties

One problem that presented quite a danger in the reconstruction of this and other bridges was the usual existence in each pier footing of a "blasting chamber," a niche in which was cached a 500-lb. live aerial bomb. This was a precaution that the Germans took in building these autobahn bridges in preparation for the time that would see the retreat of the German army through their own land. In an emergency then, a bridge could be easily and efficiently destroyed by setting off a main switch near the location. These bombs had to be located and destroyed before reconstruction on a bridge could begin. Locating them was a ticklish and hazardous job. Another unseen foe were the "duds," bombs dropped by Allied planes that had failed to go off. More than once, unfortunately, these unexploded bombs were discovered by accident.

These bridges and rails and roadways that were built by the Army Engineers served their immediate purpose—that of winning the war. Now, in peacetime, these structures are being replaced by the old familiar designs as fast as the European nations can regain their feet financially and materially.

BONEYARD BILGE . . .

(Continued from page 16)

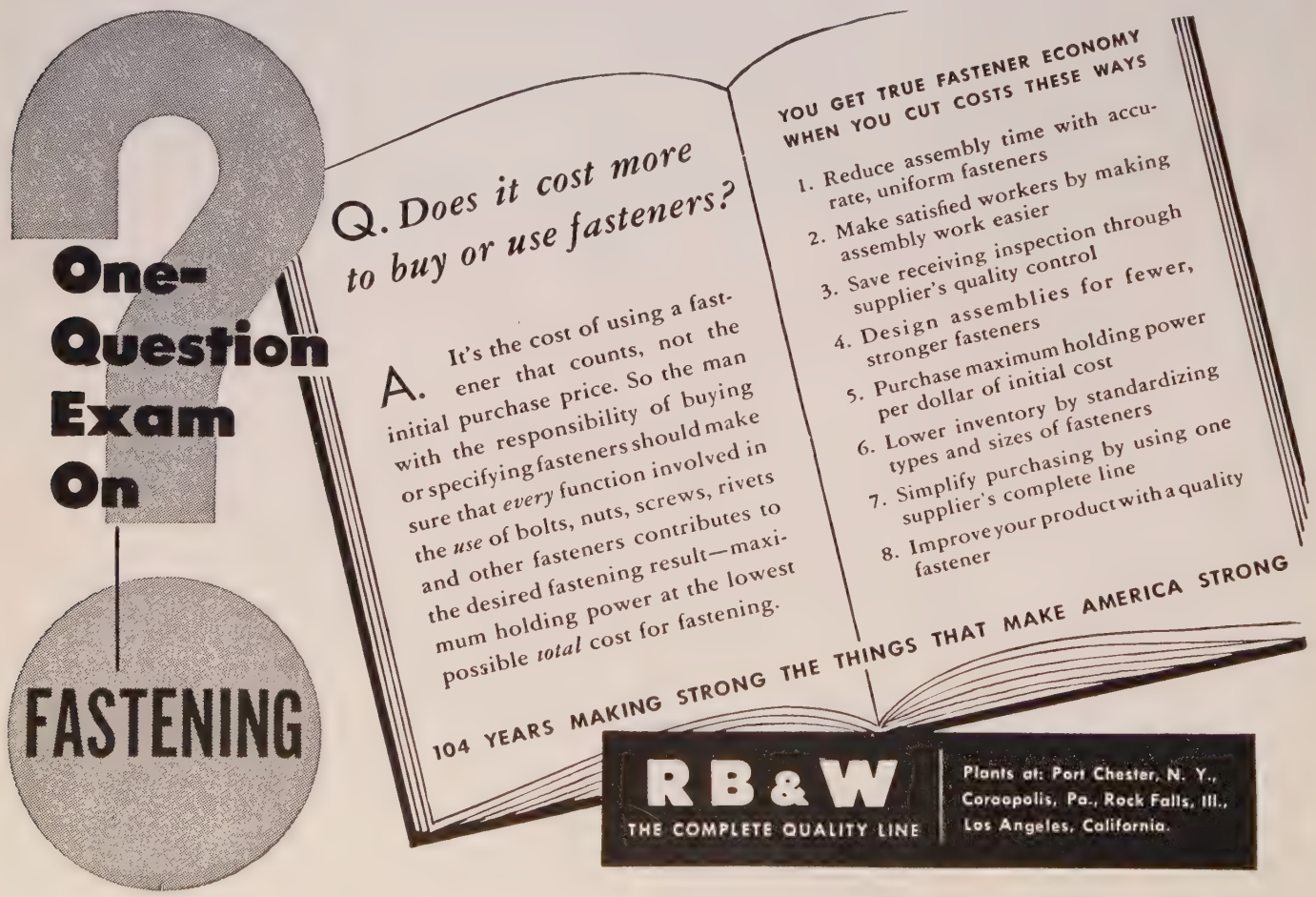
"You'll find me in the Administration building. Turner's the name," was the nonchalant reply.

* * *

Have you ever wondered why those huge square screens are on the E.E. Research lab?

They are used for testing antennas of all sizes and shapes. The antennas are placed through the windows into the square hole at the center of each screen. The wire netting acts as a base plate, with the same effect as the surface of a steel building or an airplane.

Impedance between the antennas and the screens is measured to find the optimum characteristics of reception and transmission.


One-Question Exam On FASTENING
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A. It's the cost of using a fastener that counts, not the initial purchase price. So the man with the responsibility of buying or specifying fasteners should make sure that every function involved in the use of bolts, nuts, screws, rivets and other fasteners contributes to the desired fastening result—maximum holding power at the lowest possible total cost for fastening.
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Experience over the years has shown Timken products to be the finest in their respective fields. And many thousands of men and women are working hard to keep them that way. No wonder it has become a habit throughout industry to look for the trade-mark "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

METALLURGY . . .

(Continued from page 12)

Process Metallurgy

Process metallurgy refers to the production of metals from their ores. Included in this field are mechanical or chemical treatment of the ore before the actual winning of the metal, in addition to the many different operations utilized in the production of metals for industry. Most engineering students receive an introduction to this branch of metallurgy from early chemistry courses.

A present example of the need for men trained in process metallurgy is concerned with current developments in titanium. Tests have shown that this metal possesses an excellent weight-strength ratio, a good capacity for working and forming, and excellent resistance to corrosion. All that prevents titanium from competing with aluminum and steel as a constructional material is the present expense in obtaining the metal. The present status of titanium is reminiscent of the early days of aluminum, when this now common metal was rare and expensive. It is hoped and expected that metallurgists can do for titanium what was accomplished in the case of aluminum.

Physical Metallurgy

The other division of metallurgical engineering, physical metallurgy, is a much larger field than process metallurgy, employing 10 to 12 times the number of men as the latter. For this reason, the University of Illinois curriculum emphasizes physical metallurgy.

In broad terms, the physical metallurgist takes the raw metal from the process metallurgist, and by many techniques of alloying, heat treatment, and fabrication, converts it into useful articles of industry. A convenient division between the physical metallurgist and other engineers is that the metallurgist is concerned with materials, while other engineers are concerned with machines. It is thus the province of the metallurgist to provide stronger and better materials for the designers in other fields to work with. This duty necessitates a close cooperation between the metallurgist and the designer, and the realization of this fact is providing many new opportunities for metallurgists in all phases of industry.

The undergraduate instruction in physical metallurgy is chiefly concerned with acquiring an intimate understanding of the internal structure of metals, the effect of this structure on the properties of the metal, and how the structure can be controlled by variations in metal composition, heat treatment, and mechanical treatment. The student is taught to use all the equipment available to metallurgists, and is given practical problems in the use of equipment and the design of treatments of metals. The required curriculum includes courses necessary for the general training of metallurgists; and technical electives are available for more specialized study, such as: the metallurgy of welding, powder metallurgy, advanced theory of the physics of metals, the metallurgy of steel castings, etc.

Graduate study is not a necessity in metallurgy, but the few men in the field with advanced degrees makes graduate training a distinct advantage. Men with the master's degree are offered jobs at salaries of $30-$50 per month greater than for the B.S., with excellent opportunities for rapid advancement.

The science of metallurgy is new and growing fast. A man who has not yet chosen his particular branch of engineering, who is concerned about the surplus of engineers being trained at the present time, and who desires to enter an active and developing field would do well to consider metallurgical engineering as a career.

WITH APOLOGIES to all C.E. students. Our stationery was printed last spring before Engineering hall became Civil. We hope our old-fashioned return address doesn't hurt anybody's pride!

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PHONOGRAPHS . . .

(Continued from page 11)

For a fact, in most phonographs the amplifier proper is capable of operating almost normally for frequencies higher than the pickup (mostly because of inertia) will generate. It would put out almost normal amounts of power at frequencies higher than the output transformer will pass, and higher than the fastest rate at which the speaker (also for mechanical reasons) will vibrate.

One of the greatest sources of trouble, and one most frequently ignored, is the output transformer between the last tube and the speaker. It takes a big, heavy, and expensive transformer to operate lower than 100 cycles and higher than 5000 cycles. The economic reason for the use of poor quality transformers can be easily understood—a typical transformer such as used in ordinary home record players costs about $2.00; a high quality unit would cost close to $16.00. The difference in expense is usually not profitable to the manufacturer. Some customers would never notice the difference, and most of the rest, conditioned to the usual muddled blare of many radios, don't care.

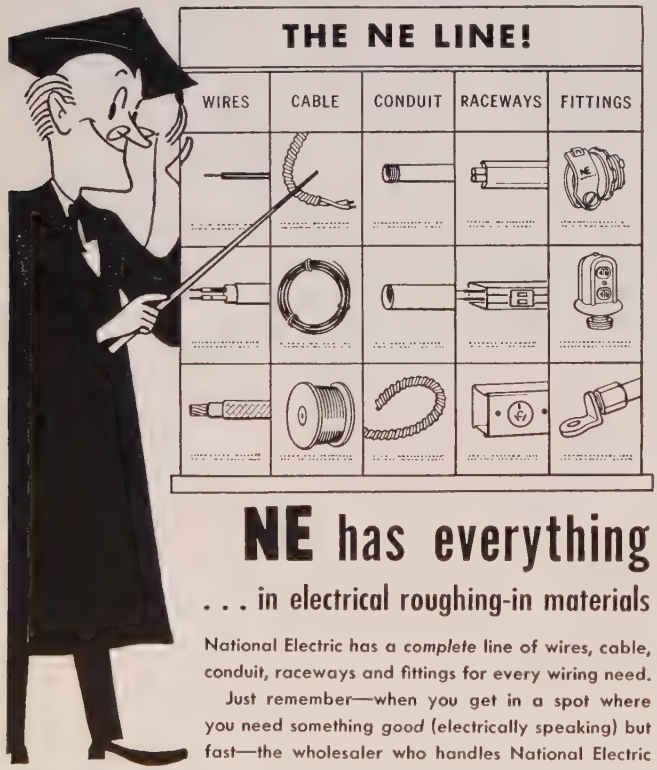
Perhaps the most troublesome link of the whole chain is the speaker. A small five-inch speaker such as found in many small players just won't operate over a wide range of frequencies. The eight-inch and larger units found in consoles are better; and the dual systems using one large speaker for the low notes (the "woofer") and one or more special small ones ("tweeters") for the highs, are excellent. But the best speaker will not sound good if lying on the floor, nor if stuffed into a little plastic box along with a cubic foot of amplifier, loop antenna, and assorted nuts and bolts. An acoustically designed enclosure containing no other equipment will do wonders for any speaker.

Practically all home record players are sections of combination radio-phonographs. All radios have audio (sound) frequency amplifiers following the tuner section; it is a relatively simple matter to include a double-throw switch at the input of the amplifier to allow it to be switched from the tuner, or radio section, to the pickup. Since practically all A.M. or standard broadcast radio stations limit the frequency of the sound they put on the air to 5000 cycles to allow stations to be crowded closer together in the band, little effort is made to allow the amplifier of the radio to operate over a wider range of frequency; therefore that limitation is imposed on the playing of records using the same amplifier.

A safe generalization might be that the response of most table model phonographs is down, at 150 and 3500 c.p.s. (the low and high ends, respectively), to 50 per cent of its medium frequency value. (This 50 per cent is just about 3 decibels, or discernible steps in loudness; the ear has a logarithmic response to volume.) As a crowning touch, practically all radios and phonographs are equipped with a so-called tone control, which is nothing more, usually, than a small filter which can be effectively used to smother frequencies above 2000 or 3000 cycles.

This tone control is a highly misunderstood piece of apparatus; it is used by the listener to give "full, mellow tone" to his amplifier. In a way, it does; most amplifiers distort high frequencies much more than lower or medium frequencies, and the suppression, to a large extent, of higher tones and overtones removes a certain amount of this distortion along with them. However, in so doing the crispness and character of the tone is sacrificed. Music played with the bass notes emphasized and the treble suppressed is indeed soothing and mellow (here enters psychology) and makes good background music; but few people will accept that type of sound as anywhere comparable to "live" music. It is the opinion of certain die-hards (including the author) that music coming over the air or played from records

(Continued on page 28)



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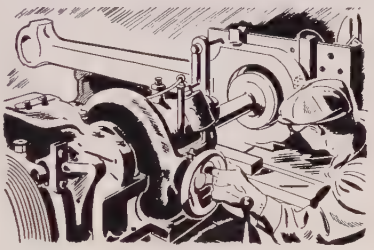
How Edwin Peterson might answer his 7-year-old son Paul. Edwin knows the answers. He's been around Norton for 30 years. In fact, ten percent of Norton employees have been on the job 25 years or more.

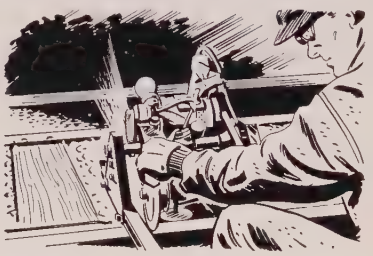
"GEE, DAD, WHY DOES IT HAVE AN UPSTAIRS?"

"To make traveling more fun. The idea is to give people more to see and do while riding faster and safer. That means more passengers for the railroads so that they can keep fares down and still add more comfort to long trips."

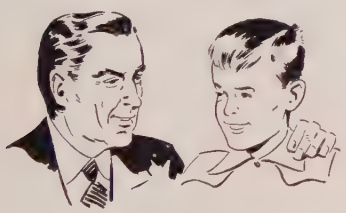
"Railroad comfort comes from many things, son. Smooth-fitting parts are important. Parts like Diesel engine crankshafts, pistons and wheels. That's why so many railroad shops use Norton grinders and Alundum grinding wheels to make parts smooth.



"Take those side rods on steam locomotives. They get farther over on the smooth side thanks to Norton internal grinding wheels. And parts are finished so accurately with Norton quality controlled wheels that they last for thousands of miles, Paul.



"Getting back to comfort . . . modern trains travel over 60 miles an hour. So, they need smooth rail joints. Those joints are welded for safety. Then, they're ground smooth and slotted with Norton grinding and cut-off wheels."



"Hundreds of other parts of modern railroad trains and tracks also get a lift from the sure touch of Norton Products. So does just about any other product you can name. That's why I'm not boasting when I say that Norton makes better products to make other products better."

NORTON

TRADE MARK REG. U. S. PAT. OFF

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NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

PHONOGRAPHS . . .

(Continued from page 26)

should sound as much as possible like that of the original orchestra.

Another of the problems of record playing is noise: noise external to the amplifier, from the motor, turntable, and the pickup (including "needle talk"—you can usually hear the pickup arm speak when the volume is turned all the way down); and the hum, hiss, and crackling actually coming through the speaker. Motor and turntable rumble is reduced by good mounting of the movable parts; buzzing and "talk" from the needle and pickup arm can be muffled by a solid, more or less sound-tight enclosure for these parts. Hum in the amplifier can be made negligible by the use of a certain amount of care in the design of the set. Many commercial companies, in the interest of economy, are rather skimpy on filters and shielding, and allow a considerable amount of hum, especially in their smaller sets.

It is extremely difficult to combat noises such as scratch picked up by the needle from the surface of records; aged records are especially noisy, as everyone knows. Noise, like any other sound, musical or otherwise, can be broken down into component frequencies, usually very many of them; and there is no band of frequencies where noise predominates—its components are spread over the entire audible spectrum and far beyond. But since most of the sound energy in music and voice is concentrated in the medium frequencies and it is largely the overtones of low intensity that occupy the higher end, the tone control can be used to eliminate these overtones and a larger percentage of the noise than of the music.

Well shaped and highly polished needles produce less scratch than other kinds; semi-permanent needles are usually better in this respect than the cheaper ones. Cactus and needles of similar composition reduce scratch in the same way as the tone control—by their lack of response to high frequencies. Keeping records free from dust and surface marring helps a great deal in eliminating noise.

After 68 years of progress, the principles of Bell's recording machine are still the basis of even the most modern transcription methods. Many of the jobs of disk recording are being taken over by wire and tape recorders because of the durability, compactness, and reuse characteristics of magnetic media; still, the flexibility of selection and excellent fidelity capabilities of the disk phonograph will guarantee its popularity in home musical entertainment for some time.

INTRODUCING . . .

(Continued from page 15)

marked by an active interest, plenty of ability, and some good politicking.

He is now president of this on-the-go organization and is serving a second term on the Engineering Council. His contributions to the latter include work on the all-engineering convocation last spring.

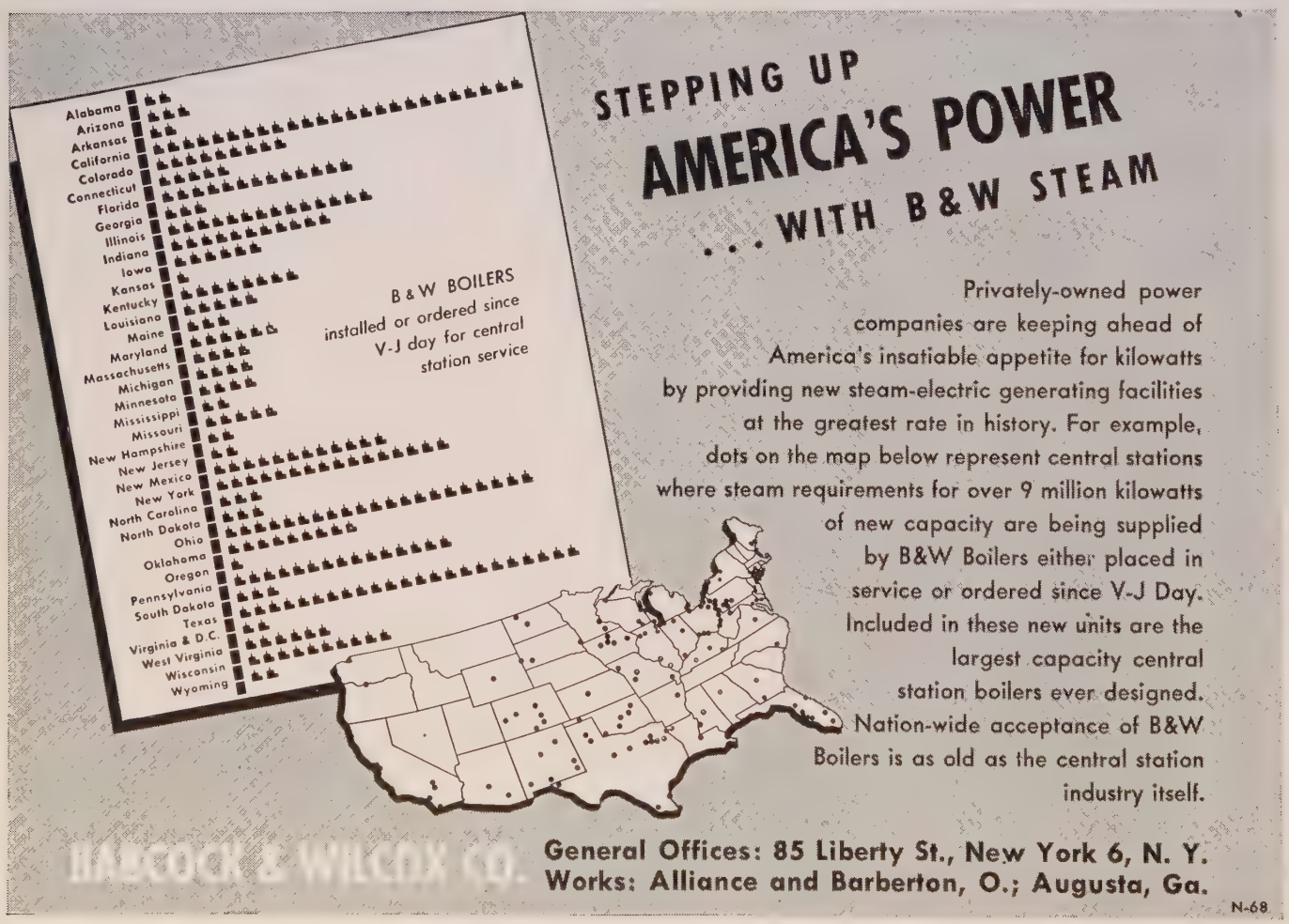
A two-timer from 'way back, Dick is also treasurer of the A.S.C.E.

While cruising the Pacific in a P.C., he came close to joining Neptunis Rex several times, but didn't quite cross into the "you-all" hemisphere. He is a member of the Sacred Order of the Grand Dragon, since he crossed the 180th meridian several times. Although he didn't make any catches, Dick did a good job of "standing by" on the bottom half of air-sea rescue around the Marianas Islands.

After leaving the Navy in July, 1946, he studied a year at Morton Junior college in Cicero. A year there was enough, and he carried his books closer to the lake—to the Navy Pier branch. At the Pier, Dick "engineered" the vice presidency of the A.S.C.E.

Part of the summer of '48 was spent fishing, sunbathing, and surveying the

(Continued on page 30)



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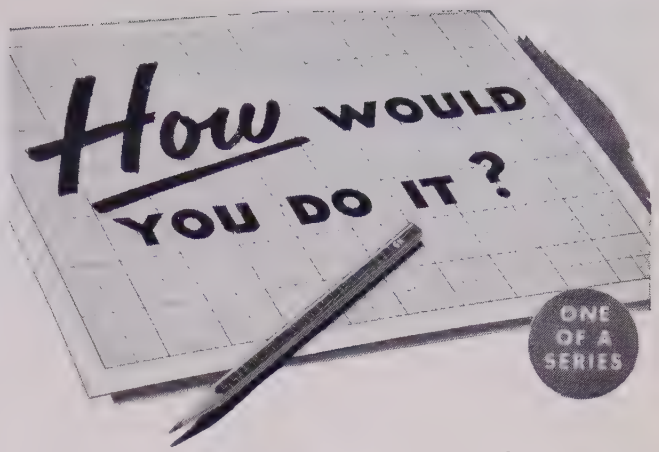
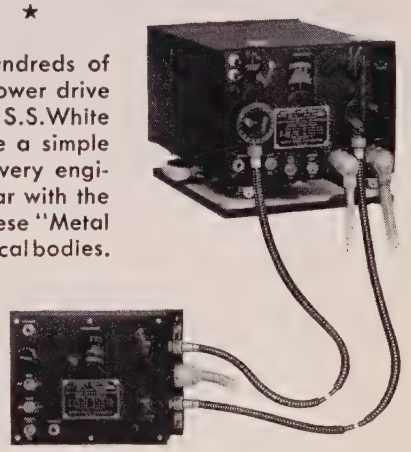


PROBLEM—You have an aircraft radio receiver. To operate it, the band selector and tuning elements must be adjusted. You want to arrange it so that these adjustments can be made right at the receiver or from a remote point. How would you do it?

THE SIMPLE ANSWER—Use S.S.White remote control flexible shafts to connect the tuning dials on the receiver to tuning cranks on a remote control unit. This arrangement leaves you free to mount the control unit anywhere you want, and assures you of smooth, sensitive tuning from any distance up to 50 feet or more. The shafts can be readily run around turns, along walls, under flooring as conditions in different aircraft may require. Any required degree of sensitivity can be obtained by connecting the shaft through simple gearing.

★ ★ ★

This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles"* for mechanical bodies.



Here's how one large manufacturer provided an answer to this problem.

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for asking. Write today.

*Trademark Reg. U. S. Pat. Off. and elsewhere

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ON THE CORNER OF WRIGHT AND GREEN

INTRODUCING . . .

(Continued from page 28)

landscape at the civil engineers' surveying camp at Blackduck, Minnesota.

This summer Dick was employed as a junior traffic engineer by the state highway department. The work consisted of intersection traffic analysis, summarization of motor vehicle volume counts, and intersection signalization planning. (Note—no politics involved.)

As far as his love life is concerned, Dick and Elaine Dafnis, of Chicago, have been keeping company since they met on the day he was discharged from the Navy. They have plans for the day that Dick finishes his education.

After graduation next February, Dick hopes to go to Yale. Research work is required for an M.S. at this top traffic school.

After that, it's traffic engineering and politics—despite the advice of his alderman father.

Math prof: "Give me an example of an imaginary spheroid."

Student: "A rooster's egg."

* * *

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SYMBOL OF 85,000 YEARS OF KNOWLEDGE

If you had been born 85,000 years ago and were still alive, think of all you would know about what happened on earth.

And if you had devoted all those years to working with one particular material found on earth . . . say aluminum . . . think what you would know about that.

Actually, man has known of aluminum for less than 150 years and didn't really start to use it commercially until 1888 when Alcoa started producing it. Yet in Alcoa's employ today is a group of men and women who possess a total of 85,000 years of aluminum working knowledge.

These people, 2,900 of them, proudly wear this button as members of the Alcoa 25-Year Service Club. Many have been in the family longer than 25 years. Their jobs range all the way from mill hand to president, from engineer to chairman of the board. They are a fourth of all the employees Alcoa had 25 years ago, pretty good indication that it's "a good company to work for".

But here's the most significant point: Sixty-one years ago, when Alcoa started, only five men were employed. Today about a million people have jobs in the aluminum industry, an industry comprised of: companies who produce aluminum from ore; companies who smelt aluminum scrap; others who make semi-finished aluminum products; and hundreds of companies who manufacture useful articles in which aluminum plays an essential part.

Today the same pioneering spirit that marked the founding of this industry is evident in Alcoa's laboratories, mills and foundries. Here men are developing new uses, new techniques that promise even more for the future of aluminum. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

SOCIETIES . . .

(Continued from page 14)

being the first student chapter chartered by the national I.E.S. which promotes interest and fellowship in illuminating engineering.

The open house held last year for the Chicago branch proved so successful that the invitation may be extended again this year. Also on the program are lectures—on the varied applications of illuminating engineering—to be given by some of the outstanding men in the field.

The officers elected for the fall term are: Charles Craig, chairman; Joan Hessler, secretary-treasurer; Bill Tometich, program chairman; Mark Estabrook, publicity chairman; and Harold Wilson, general program chairman.

ETA KAPPA NU

The aims of this electrical engineering honorary are to advance the electrical engineering profession and to stimuate and reward scholastic achievement. The organization has been accomplishing this on the campus since its establishment in 1904. The requirements for admission are not only high scholastic standings but acceptability to the other members.

Professor A. R. Knight advises the local Alpha chapter and the officers for this term are: Bob Stone, president; Sol Mann, vice president; Dick Gorozdos, treasurer; Ed Kitsch, corresponding secretary; Bob Lewis, recording secretary; and Isaac Nehama, bridge correspondent.

A.S.C.E.

Although this organization is officially called the American Society of Civil Engineers, the general and architectural engineers are more than welcome to join and take part in the activities.

Finishing up their affairs last spring was the Midwestern conference of the A.S.C.E. which many of the members of the local chapter attended.

The A.S.C.E. has a system of electing officers that has worked out extremely well in the past few years. The vice president of the organization, upon serving one term in that office, takes over the presidency. Thus the men leading the group have had experience at the job and the business is handled smoothly at all times.

Professor M. O. Schmidt is their faculty adviser and Don R. Anderson, the president. In a vote-by-mail election held last spring, William T. Bristow was appointed vice president; Charles C. Swensen, secretary; Richard Kanak, treasurer; Donald Hankins and Jacob Whitlock, Engineering Council representatives.

All the latest dope can be obtained by reading the A.S.C.E. bulletin board opposite the *Technograph* office.

S.A.E.

The purpose of the student chapter of the Society of Automotive Engineers is to cater to the students' interest in the "engineering practices connected with the design, construction, and utilization of automotive apparatus."

The meetings of the S.A.E. are designed to appeal to a variety of interests. For one of the first meetings this fall it was planned to have that famous man of the race track, Mr. Wilbur Shaw, as a guest speaker. This is but a sample of the many interesting things to be found at the S.A.E. meetings.

Prof. William Hull is the honorary chairman of the S.A.E. Student officers are: Wallace Hopper, chairman; Roy Morling, vice chairman; John Corrigan, recording secretary; William Gibb, corresponding secretary; Robert W. Giertz, treasurer; Henry S. Chodacki, Council representative.

The executive committee is headed by Robert K. Reynolds; program and

(Continued on page 34)

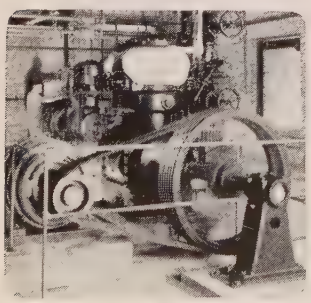
Ice—2,000 Tons of It—Stored for Use in Summer

Another COMMUNITY REFRIGERATION CENTER Succeeds with Frick Refrigeration

The Mutual Cold Storage Cooperative, located between Broadway and Timberville, Va., serves the prosperous Shenandoah Valley in many ways: makes 50 tons of ice daily, stores 2,000 tons, ices trucks and railway cars, operates several ice routes; quick-freezes 50,000 pounds of poultry per day; stores 375,000 bushels of apples and 1½ million pounds of frozen foods; processes fresh foods, rents 1,285 lockers; and provides cooling services to three large cooperatives—for fruit, poultry and meats—nearby.

For nearly 20 years the Mutual plant has used Frick Refrigeration, now has 10 Frick machines. Any community—YOUR community—could profit from a similar Refrigeration Center. Let us give you details: write

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, is approved under the G. I Bill of Rights.



Two of the Ten Frick Machines at Broadway

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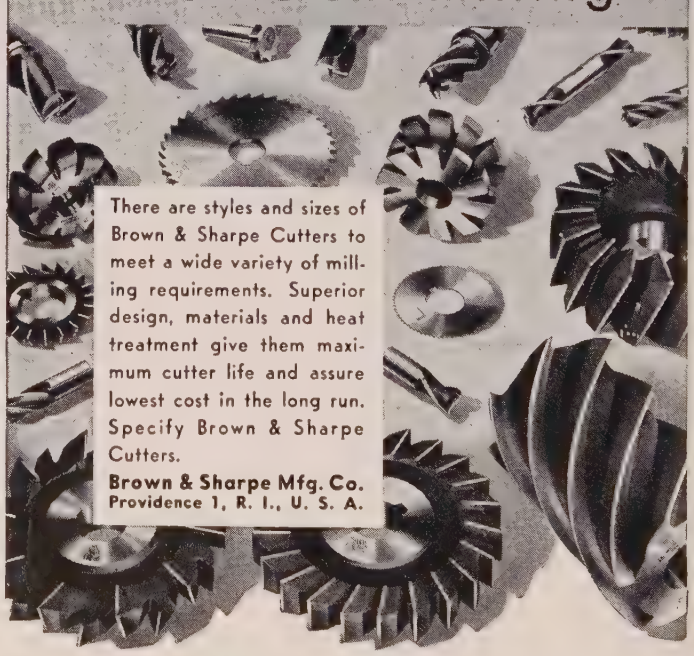

There are styles and sizes of Brown & Sharpe Cutters to meet a wide variety of milling requirements. Superior design, materials and heat treatment give them maximum cutter life and assure lowest cost in the long run. Specify Brown & Sharpe Cutters.

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Glass that you can twist, bend, roll...

This is a ribbon of glass so thin that it takes about *one thousand* thicknesses of it to make a stack an inch high.

It is so flexible that you can roll it on a reel, twist it into a spiral, wrap it around your arm.

If you should test it electrically, as Corning scientists have done thousands upon thousands of times, you'd find that it has superior electrical insulating and dielectric properties—equal to high-grade mica.

One of the first experimental uses of Corning ribbon glass has been to alternate strips of it with metal foil and fuse them together to make electrical capacitors—or condensers—similar to those made of mica for television, radio, and other electronic equipment.

Ribbon glass capacitors, which can be uniformly produced by machine, have already shown many advantages over those made with other materials.

Being hermetically sealed, they need no enclosing case. They can operate at temperatures which are too high for other capacitors to withstand. They do not deteriorate with age or continued use. Small ones can do the job of conventional capacitors of larger size. And for certain installations only a ribbon glass capacitor will serve.

And Corning research indicates that making capacitors is not the only problem that ribbon glass may solve. It can be laminated with resin and then cut, formed, shaped and used for other electrical purposes.

Because ribbon glass is uniformly thin, it has already been considered for such other uses as microphone diaphragms and windows for Geiger counters that measure radio-activity.

Glass ribbon is another striking example of how Corning, noted for its Pyrex brand products, has developed glass into a most versatile engineering material.

That's why we invite you—when you've finished school and started work—to call in Corning before your product planning reaches the blueprint stage. *Corning Glass Works, Corning, New York.*

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SOCIETIES . . .

(Continued from page 32)

pubicity, by E. R. Gibbs; and membership by George W. Sawicki.

Membership in the S.A.E. is open to all engineering students. An invitation to become a member is extended to all students, and especially to freshmen.

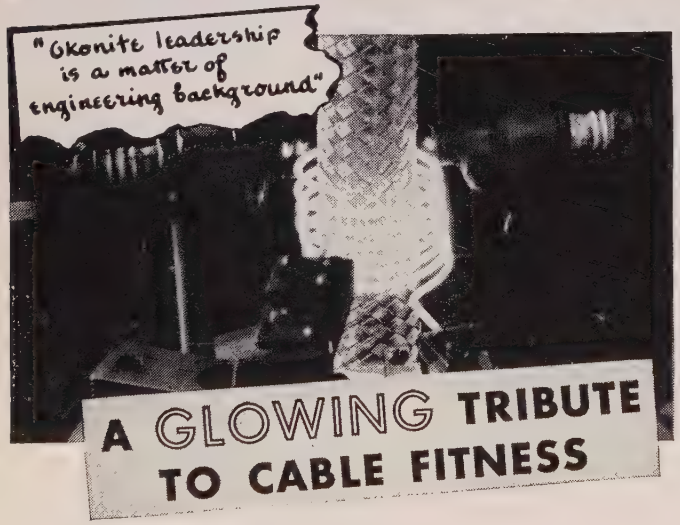
PI TAU SIGMA

Pi Tau Sigma is the national honorary mechanical engineering fraternity on the campus. The local Alpha chapter has been with us since way back in 1916 when the fraternity was estabished.

The active members are chosen from the junior and senior classes on the basis of personality, scholarship, leadership, and their probable success in the future in technical engineering.

At the annual spring banquet held last semester, 27 new pledges were initiated and the officers elected for this term. President of the local chapter is Boubene M. Jaremus. Other officers include: Roland J. Benjamin, vice president; Joseph T. Ream, treasurer; Thomas C. Jenkins, recording secretary; and Donald R. Tarne, corresponding secretary.

(Continued on page 36)



Is a cable covering flameproof? Will it resist high temperatures when it comes to actual service?

Long before a cable is manufactured, questions like these are answered in the Okonite laboratories, proving ground and in various testing departments of the Okonite plants. The picture above shows a flame test. The measured current that makes the coils glow makes it possible to reproduce test after test without variation. The Okonite Company, Passaic, New Jersey.

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by CARL MALMBERG
Superintendent, Tank and Plate Shop
ALLIS-CHALMERS MANUFACTURING CO.
WEST ALLIS WORKS
(*Graduate Training Course—1930*)

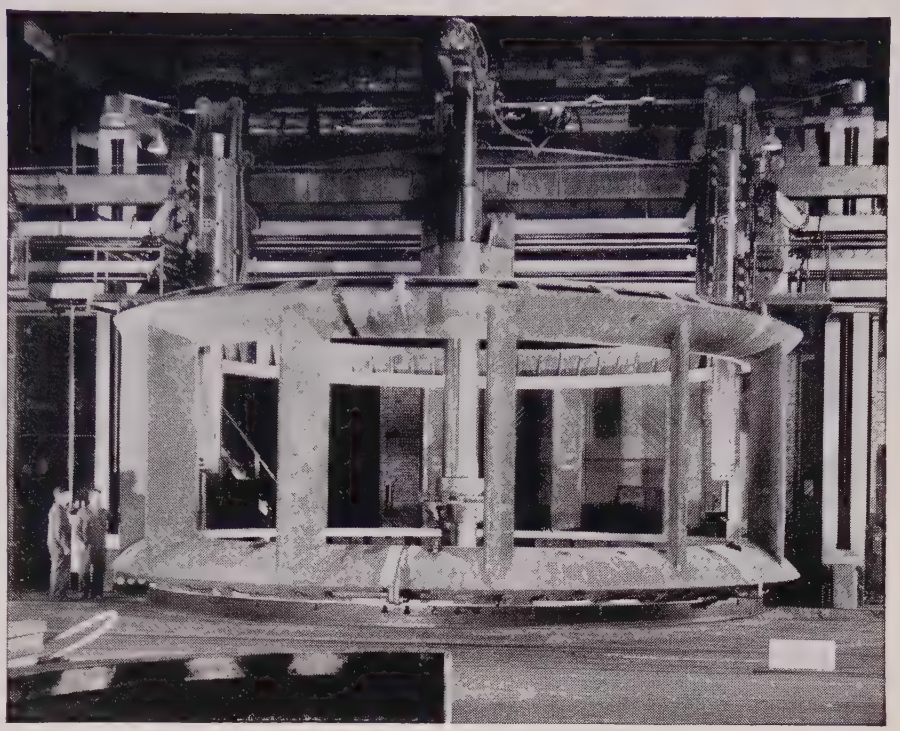
PRODUCTION METHODS have become a good deal more technical and complicated in the last few years. There is a big difference between the way we do things now and the way we did them when I left the Allis-Chalmers Graduate Training Course to work in the machine shop in 1930. That is why there are more and more opportunities in the manufacturing end of the business for young engineers who get a thrill from watching a project grow from a roll of blueprints to a big electric power installation or machinery for a giant processing plant.

CARL MALMBERG

Close Coordination

In my section of the shop we specialize in fabricating machines and parts from sheet and plate steel. We work closely with the design engineers to develop the most economical way of producing their designs and we do much designing on our own. We work closely with every other manufacturing department, because more and more Allis-Chalmers products are being designed to replace cast members with welded members, and in my work we do the welding for the whole plant.

Welding stator yoke on 38,889 kva hydraulic turbine-driven generator.



Machining speed ring for a 55,000 hp turbine on a 40' boring mill, one of the largest in the country. Many A-C machines and methods are unique because of the tremendous size of work pieces and wide variety of operations required in building the world's greatest range of industrial equipment.

One recent interesting project was the fabrication of stainless steel buckets for impulse-type hydraulic turbines to replace the old cast-type buckets. Working with design engineers and hydraulic engineers, our tank and plate specialists developed a design and method of manufacturing that produced buckets with several times the life of the old type.

Opportunities Everywhere

New developments in every department mean almost endless opportunities for young engineers. Right now, the erection shop is building a big crusher for processing taconite in the Mesabi range, and we are supplying most of the other ore processing equipment for this gigantic plant, too. At our Norwood plant, engineers have completely rebuilt the production system on motors and small pumps for greater efficiency and lower costs.

In fact, here at Allis-Chalmers there are big opportunities for young engineers in all phases of engineering work—design, research and development, manufacturing, sales and erection—in nearly any industry you can name. For Allis-Chalmers builds primary equipment for electric power . . . mining and ore processing . . . pulp and wood products . . . flour milling . . . steel . . . agriculture . . . public works . . . for *every* basic industry.

The thing that influenced me most when I left the University of Illinois to join Allis-Chalmers, was the tremendous breadth of opportunity. Some of my friends from that GTC class of 1930 are sales engineers now, some are design engineers, some have traveled around the world with erection crews. I chose manufacturing because I like to see things take shape before my eyes. I tried a good many things before I made my choice and my choice has been good.

Write for details of the Allis-Chalmers Graduate Training Course—requirements, salary, advantages. Representatives may visit your school. Watch for date.

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

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THE ENGINEERING STUDENT

and the

ILLINOIS SOCIETY OF

PROFESSIONAL ENGINEERS

SOCIETIES . . .

(Continued from page 34)

A.S.A.E.

A little to the north of Tolono and just south of the Union building you'll find the agricultural engineering building. It is there that the A.S.A.E.'s abide.

Anyone going by there this semester had best be quick footed as these boys really move when there is something to be done. You probably saw them lassoing prospective members last month during the registration week.

The full program for this fall hasn't been announced yet but if you want all the straight info, see Errol Rodda who was elected president last spring. If you can't find Errol, try one of these officers: Neil Bogner, vice president; James Andrews, secretary; Howard Wakeland, corresponding secretary; Russell Mighell, treasurer; and Carl Jacobs, Engineering Council representative. Adviser to the A.S.A.E. is Jim Curtis.

He is happy whose circumstances suit his temper, but he is more excellent who can suit his temper to any circumstances. —David Hume.

What we anticipate seldom occurs: what we least expect generally happens. —Disraeli.

LEATHER PLUS PROPER TENSION Gives Continuous, Dependable Service
An ordinary trouser's belt is an everyday reminder of the continuous, trouble-free service leather plus proper tension can give.
Modern power transmission uses these same two ingredients in the Uni-Pull drive. Uni-Pull teams a modern flat leather belt with a tension-controlling motor base and gives today's industry a flexible, compact, long service drive . . . a drive that makes the most of the inherent power-carrying advantages of leather.
The Modern Uni-Pull Drive
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UNIFORM PULL ACROSS THE PULLEY
Tension-Controlling Motor Base
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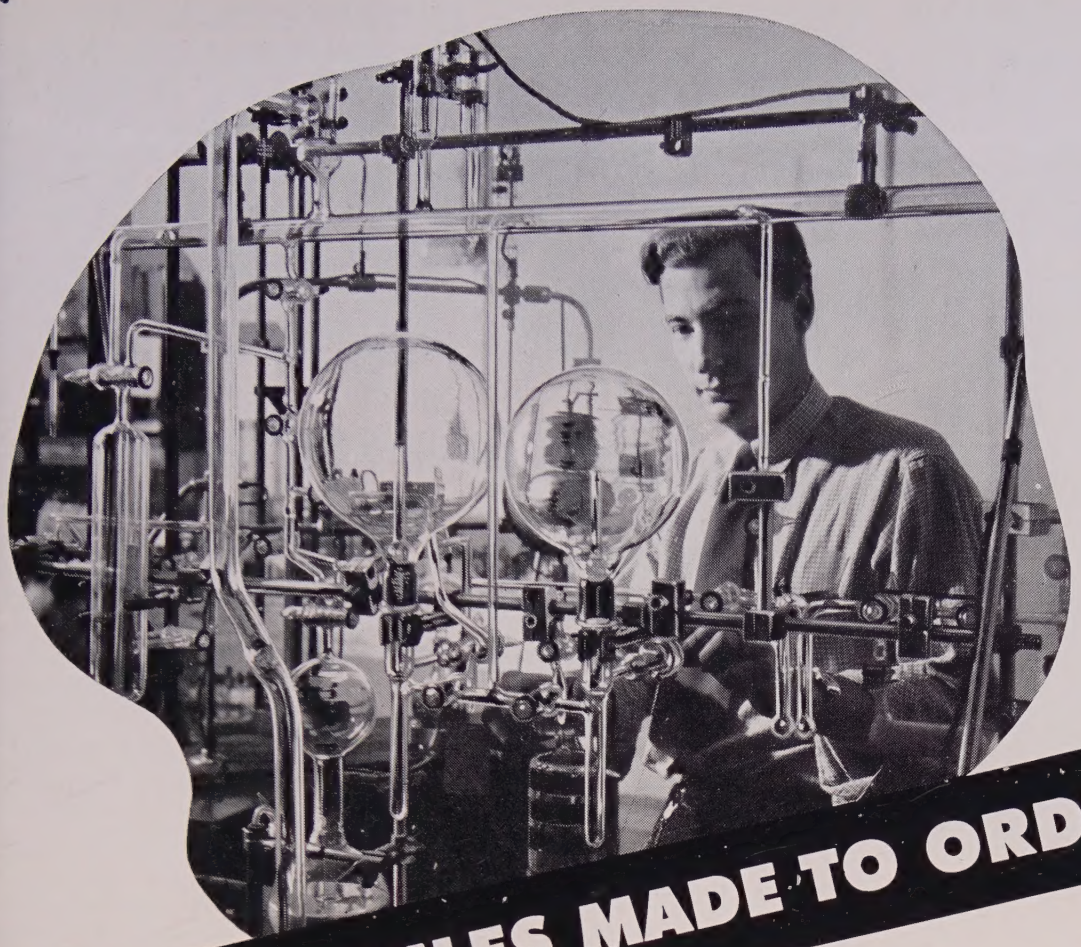

MOLECULES MADE TO ORDER

Year by year, month by month, oil industry chemists find new, fascinating possibilities in the hydrocarbon molecules that make up petroleum. They have learned many ways to convert them into new and more valuable molecules.

One result of this experimentation has been a flexibility that permits stepped-up output of whichever petroleum products are most urgently required. When the primary need was for vast quantities of aviation gasoline to help win the war, research showed how it could be produced. In a peace-time summer, the great demand is for an ocean of automobile gasoline; in winter, less gasoline and more fuel oil are needed. Research tells the industry how to make petroleum serve the public more efficiently.

Standard Oil is a leader in petroleum research. Many remarkable developments have come from our laboratories; many more are sure to come, in the future, if we continue to attract good men, furnish them with the most modern equipment, and provide an intellectual climate in which they can do their best work.

We *are* continuing.

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NEW DEVELOPMENTS . . .

(Continued from page 2)

magnets of different strengths. The values thus obtained are used, in conjunction with a set of previously determined calibration curves for each magnet, to obtain the total thickness of the coating and the relative thickness of the copper and nickel layers.

Composite coatings, nickel over copper on steel, are used extensively in automotive industries for economical protection.

The thickness of each component layer of similar coatings can be measured to an accuracy of about 15% without causing any damage to the tested finish.

Ozone Water Treatment

The world's largest Ozonator water-treatment generator unit has been installed in a Philadelphia filtration station by the Welsbach Corporation.

Sparking of glass electrodes creates the gas, ozone, which removes taste and odor from ordinary water. Treatment will require an average of 200 kilowatt hours for each million gallons.

Color Film

DuPont has made a basic improvement in photographic color film for the motion picture industry.

The result of many years of research, this product is an entirely new synthetic polymer which is also a color former. It takes the place of both the gelatin binder and the color former heretofore used in color films. Combination into a single material results in excellent color reproduction and improves image sharpness. This film is for the printing of 35mm. positives for theaters.

New Hydraulic Oil

For use in hydraulically operated machine tools that pressure-feed lubricant away from the hydraulic system, Sun Oil company has introduced a new dual-purpose oil.

Called Lubeway, the new lubricant has already been subjected to more than a year of exhaustive testing in machine tool builders' laboratories and under regular production conditions in industry.

Ordinary hydraulic oil lacks the film strength and metal-wetting properties needed for lubrication. These deficiencies caused excessive wear and made close tolerances and fine finishes impossible. The new oil, a blend, gives good lubricating as well as hydraulic performance.

Trouble is usually produced by those who don't produce anything else—Success.

THE DU PONT DIGEST

FOR STUDENTS OF SCIENCE AND ENGINEERING

Research across the U. S. A.

YOUNG SCIENTISTS ARE BUILDING CAREERS WITH DU PONT FROM CONNECTICUT TO TEXAS

When you think of Du Pont research, you may think first of Wilmington, Delaware. Actually, only eight of the Company's 36 research groups are located there. Du Pont scientists now pursue their studies in 11 states scattered from Connecticut to Texas.

Each of these laboratories is a self-contained operation. It may be devoted in part to fundamental research and applied research, or to investigations looking to the development of new products—sometimes a combination of these activities.

An unusual Du Pont laboratory is one opened last year at Newburgh, New York.

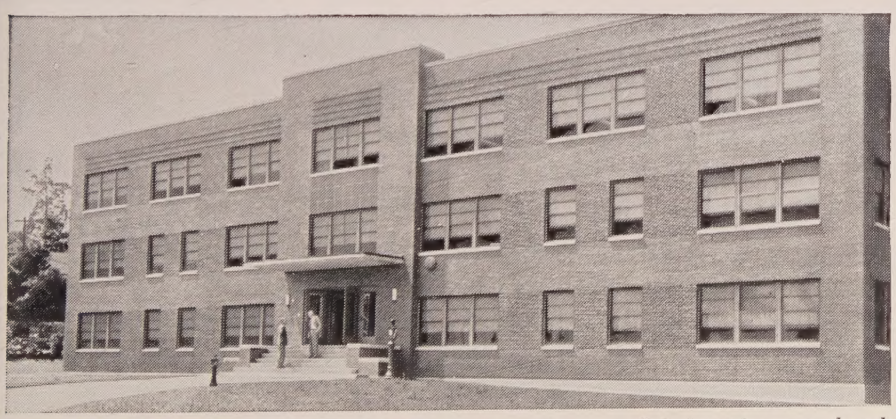
Inside the Laboratory

In the three-story building at Newburgh, scientists have at their disposal the most modern equipment for study of coated fabrics and plastic sheetings under all sorts of conditions. For example, a new product can be tested in a room maintained at a temperature of −20° F. In other rooms, the effects of high temperature and humidity can be studied. Equipment is available for testing tensile strength, tear resistance, fading, flex and flame resistance, and many other characteristics. One of Du Pont's 33 libraries has quarters in the building; there is a photographic darkroom, as well as offices, conference and work rooms.

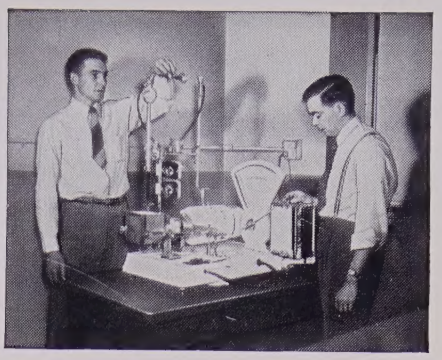
The Newburgh Laboratory works closely with the adjacent plant, which makes "Fabrikoid" pyroxylin coated fabrics, "Fabrilite" vinyl resin coated fabrics and plastic sheetings, "Tontine" washable window shade cloth, bookbinding materials, and other coated and impregnated fabrics and plastic sheetings for many uses.

Research at Du Pont

Research has long been a major activity at Du Pont, and it flourishes in an atmosphere of appreciation, encouragement and patience. The new products, the new plants, and the new and better jobs of the years to come will develop from the painstaking research programs being carried on today in the laboratories.



Newest Du Pont laboratory, *at Newburgh, N.Y., was opened last year. It is devoted to research and development work in the field of coated and impregnated fabrics and allied products.*



H. A. Van Etten, *B. S. Ch., Colgate '42, and E. R. Grisé, M. S. Ch., Worcester Polytechnic Institute '48, investigating the properties of vinyl compounds used in plastic-coated fabrics.*

K. F. Richards, *B. S. Ch. E., Cornell '48, and E. K. Holden, M. S. Ch. E., Delaware '48, studying "Teflon" tetrafluoroethylene resin insulating material with special apparatus at the Newburgh Laboratory.*

Choice of Careers

Each of the Du Pont manufacturing departments conducts continuous research. They operate much like separate companies, with interests ranging from heavy chemicals to plastics and textile fibers. Each holds challenging opportunities for college-trained chemists and physicists, as well as chemical, civil, electrical, industrial and mechanical engineers, also those specializing in production, sales and many other fields.

In this alert, ever-growing organization, young graduates can choose from a variety of careers the one that suits them best as their ability and interests develop.

DU PONT
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...THROUGH CHEMISTRY

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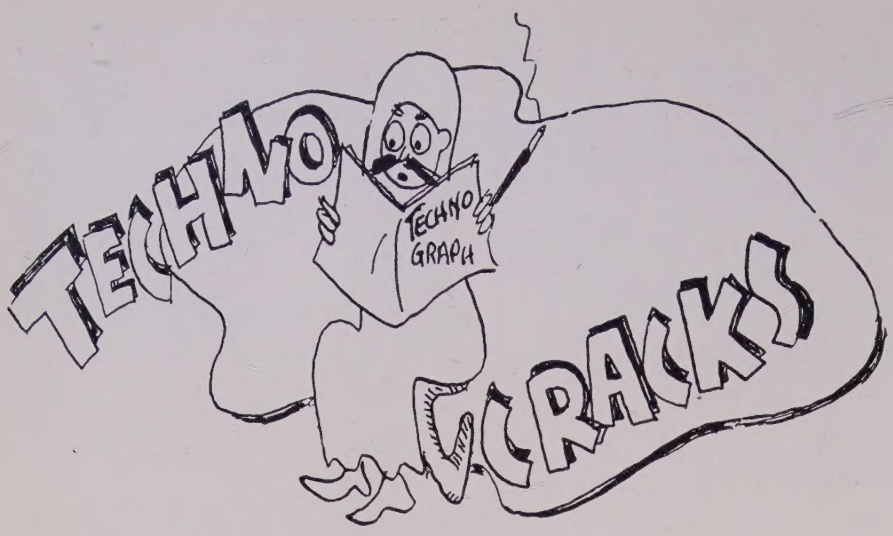

What are little girls made of?

Among other things, one girl is made of enough glycerin to furnish the bursting charge for one naval shell; she has enough lime to whitewash a chicken coop; enough sulfur to rid a dog of fleas; and enough chlorine to sanitize three swimming pools.

* * *

An engineering professor is one who passes as an exacting expert on the strength of being able to turn out, with prolific fortitude, strings of incomprehensible formulae, calculated with micrometric precision from extremely vague assumptions which are based on debatable figures acquired from inconclusive tests and quite incomplete experiments carried out with instruments of problematic accuracy by persons of doubtful reliability and of rather dubious mentality with the particular anticipation of disconcerting and annoying a group of hopelessly chimerical fanatics described altogether too frequently as students. —*Washington Engineer*

* * *

"Cheer up, old man. Why don't you drown your sorrow?"

"Silly boy! She's stronger than I am."

* * *

The manager of a building firm stared at the heap of rubble that had been a house he was building.

"What happened?" he asked the foreman.

"Durned if I know," said the strawboss. "We took the scaffolding away, and plop! The whole shebang came down."

"You idiot! I told you to leave the scaffold up until the plumbing and wallpaper were put in!"

* * *

"Sam," said Rastus, who was reading in the paper of a number of fatal accidents, "if you was to take your choice 'twixt one or t'other, which would you ruther be in, a collision or an explosion?"

"A collision."

"How come?" Rastus asked.

"Why man alive, if you's in a collision, thar you is, but if you's in an explosion, whar is you?"

* * *

He who works with his hands is a laborer. He who works with his hands and head is a craftsman. He who works with his hands, head, and heart is an artist.

And he who works with his hands and his head and his heart and his feet is a salesman.

* * *

The reason no woman ever married the man in the moon is because he makes only a quarter a week, gets full once a month, and stays out all night.

* * *

The three ages of womanhood are:

20—Attractive
30—Attentive
40—Adhesive

* * *

She held the diamond between trembling fingers and stared at the man before her. What should she do? Should she cast it from her, or would it be better to reconsider? What would he say? What might he do? His eyes were staring into hers with stony intensity.

The diamond seemed to burn her fingers. She felt weak and incompetent—incapable of decision. Bright spots danced before her eyes; she shuddered and drew a long breath. Yes, she must do it; there was no escape! Blindly she shut her eyes and tossed the diamond on the table in front of her—it was done!

. . . And then . . . she heard her partner's sigh of deep relief as he gathered up the trick!

* * *

From a park bench:

"Do you think my eyes are like the stars?"

"Yeah."

"And do you think my teeth are like pearls?"

"Yeah."

"And do you think my hair is like spun gold in the moonlight?"

"Yeah."

"Oh, Joe! You say the most wonderful things!"

* * *

Didja know the stork kids the whole world?

* * *

At that, the life of a bill collector isn't full of unpleasantness; practically everybody asks him to call again.

* * *

Nothing cooks your goose quicker than a boiling temper.

* * *

Calvin: "Where did you get that girl—buck teeth, cross-eyed, bow-legged, stringy-haired?"

Kenneth: "You needn't whisper. She's deaf, too."

* * *

"Give me another pound of your ant powder," said the man rushing into the store.

"I'm glad to see that you like the powder," said the clerk.

"Yes," snapped the customer, "I've got one ant unconscious with the first pound and I figured I'll be able to kill him with the second."

* * *

A farmer's wife had become mentally deranged. As they carried her out of the house in a strait jacket he remarked: "Shore don't know what got into her—she ain't been out of the kitchen in 25 years."

* * *

Sign on a cross-country truck: "This truck stops for all crossroads, railroad crossings, blonds, brunettes, and will back up 20 feet for a redhead."

* * *

After the visitor had talked all evening about the size and fierceness of the mosquitoes, the old residenter was becoming much annoyed.

"Just look at them swarm," the guest complained. "Why don't you screen the porch?"

"That, sir," the old man replied, "would be unsportsmanlike. We use mouse-traps."

* * *

A lady called the doctor: "My husband has swallowed a mouse."

"Get back to him," said the doctor, "and try waving a piece of cheese in front of his mouth. I'll come right over."

When the doctor reached the house, the man was lying flat on the floor while his hysterical wife was waving a piece of salmon close to his mouth.

"I told you to try cheese," cried the doctor.

"I know that," shrilled the woman, "but I've got to get the cat out first!"